March 22, 1934

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Engineering News-Record

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New Rules for Business

• Last Monday, March 19, the General Contractors' Code became effective. From that date forward contracting becomes almost a new business, so different are many of its practices from those to which this generation of builders has been accustomed. Furthermore, this new procedure is mandatory under the law. There is no alternative but for every contractor who takes a job of $1,000 or more to play the game according to the new rules.

• There may be hardships at first. There is certain to be confusion. But the promise of a better, more stable and more prosperous industry under code government is a reward worth the effort. Patience and cooperation, sympathy with the ideals set and with the code officials who are faced with the difficult task are immediate necessities. Above all familiarity with the regulations is essential. An authoritative analysis of the more important of these is given in this issue.

Beginning a Series of Articles on

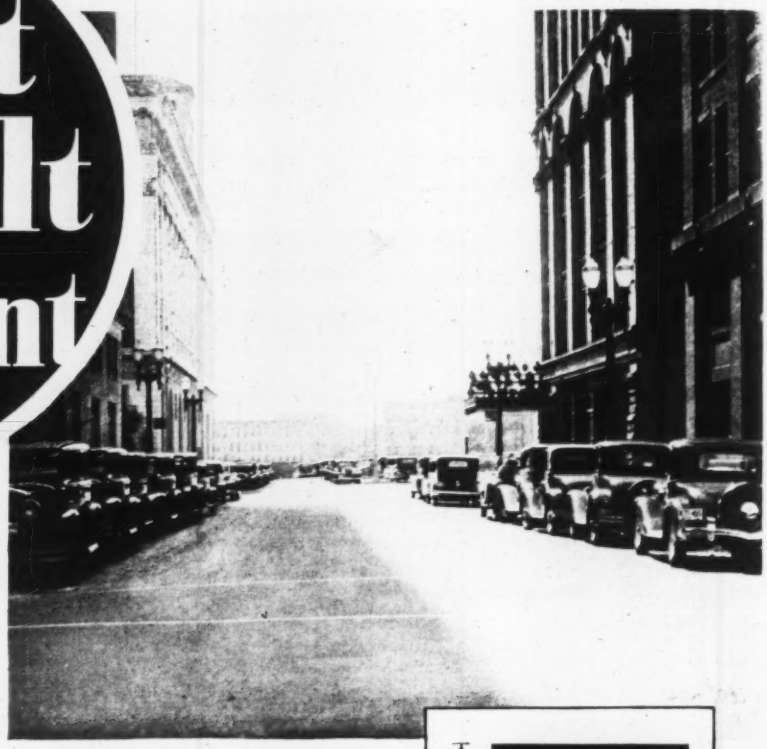
The San Francisco-Oakland Bridge

By C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff

Respectively Chief Engineer, Bridge Engineer and Engineer of Design, California Toll Bridge Authority

For good roads, safe roads, economical roads – use ASPHALT

Sheet Asphalt Pavement



THIS type is one of the oldest established pavements which has been used mainly on city streets and primary highways. It is easily repaired for service cuts, is low in maintenance cost, quiet, non-skid, and easy to clean and keep in a sanitary condition. It is used for resurfacing streets and for new construction.

It consists of a wearing course and a binder course, each usually being laid to a depth of one and a half to two inches, depending on traffic, on a suitable foundation of sufficient strength to suit the traffic.

The wearing course consists of a hot mixture of paving asphalt cement, mineral dust and sand:

Typical Mixture

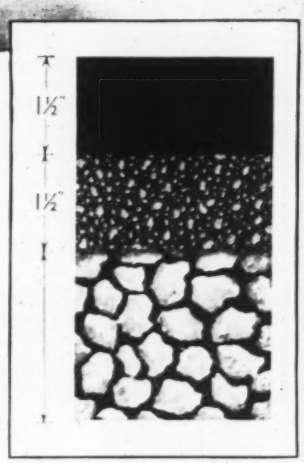
	Per Cent by Weight
Asphalt Cement	10.0 to 13.5
Mineral Dust	10.5 to 15.0
Sand	71.5 to 79.5

The binder course consists of a hot mixture of asphalt cement, sand and mineral aggregate.

Typical Mixture

	Per Cent by Weight
Asphalt Cement	5 to 8
Sand	25 to 35
Mineral Aggregate	60 to 70

The foundation can consist of a newly constructed base course such as hydraulic cement concrete, asphalt cement concrete, macadam, or other types which have sufficient strength for traffic requirements.



Rough uneven existing streets and roadways can be made smooth by resurfacing with sheet asphalt, using the existing streets as a foundation for this new wearing course.

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In the News:

THE ST. LAWRENCE SEAWAY TREATY was voted down in Congress during the week, against the President's recommendation. Prominent among the opponents were every seaboard state, the Mississippi River states and coal-mining states fearful of hydro-electric power development. Canada is not unanimously in favor of the treaty either, as evidenced by an opposing resolution forwarded to Ottawa by the St. John board of trade.

PWA has, for the first time, made statistics available that explain the disposition of its $3,300,000,000 fund. More than $1,000,000,000 was allocated to federal departments and 1 1/3 billions went for CWA, CCC, warships, highways, and divers federal projects. Non-federal allocations, excluding railroads, total only $628,000,000.

THE NORTHWEST REGIONAL PLANNING conference held in Portland, Ore., under the direction of the PWA regional adviser registered an attendance of about 1,600. Discussion of economic use of Bonneville and Grand Coulée power had a prominent place on the program.

THE RFC is continuing its loans for refinancing drainage and irrigation districts under the provisions of the Emergency Farm Mortgage Act. Thirteen loans were made last week, bringing the total to something over $30,000,000.

REPORTS from Washington are to the effect that an amendment to the municipal bankruptcy bill is in preparation which will require the consent of 80 per cent of the security owners when a reduction of principal is sought, while only 66 2/3 per cent would need to give consent when the question is one of interest or maturity dates.

"THE GREATEST OBSTACLE to collective bargaining are employer-dominated unions, which have multiplied with amazing rapidity since the enactment of the Recovery Act."—U. S. Senator Robert F. Wagner.

"RELIEF EXPENDITURES only tend to stimulate business activitity. They cannot for long take the place of it."—O. M. W. Sprague, former advisor to the U. S. Treasury.

In This Issue:

ANALYSIS SHOWS that emergency highway expenditures by the federal government during the past few years have furnished a remarkably large volume of employment. This fact is in striking contrast to the President's reported dissatisfaction with the highway part of the recovery program. An article in this issue considers volume of employment, rate of putting men to work, distribution of employment and future prospects of employment in highway work.

FOR THE NEXT FEW YEARS the San Francisco-Oakland Bridge will be prominently in the news. In many respects it is the most ambitious bridge-building job ever undertaken, and like all great projects will contribute in important ways to engineering advance. Its complete story will be recorded in the pages of this journal. The first of these authoritative articles, published this week, reviews the history of the project and outlines the evolution of the design.

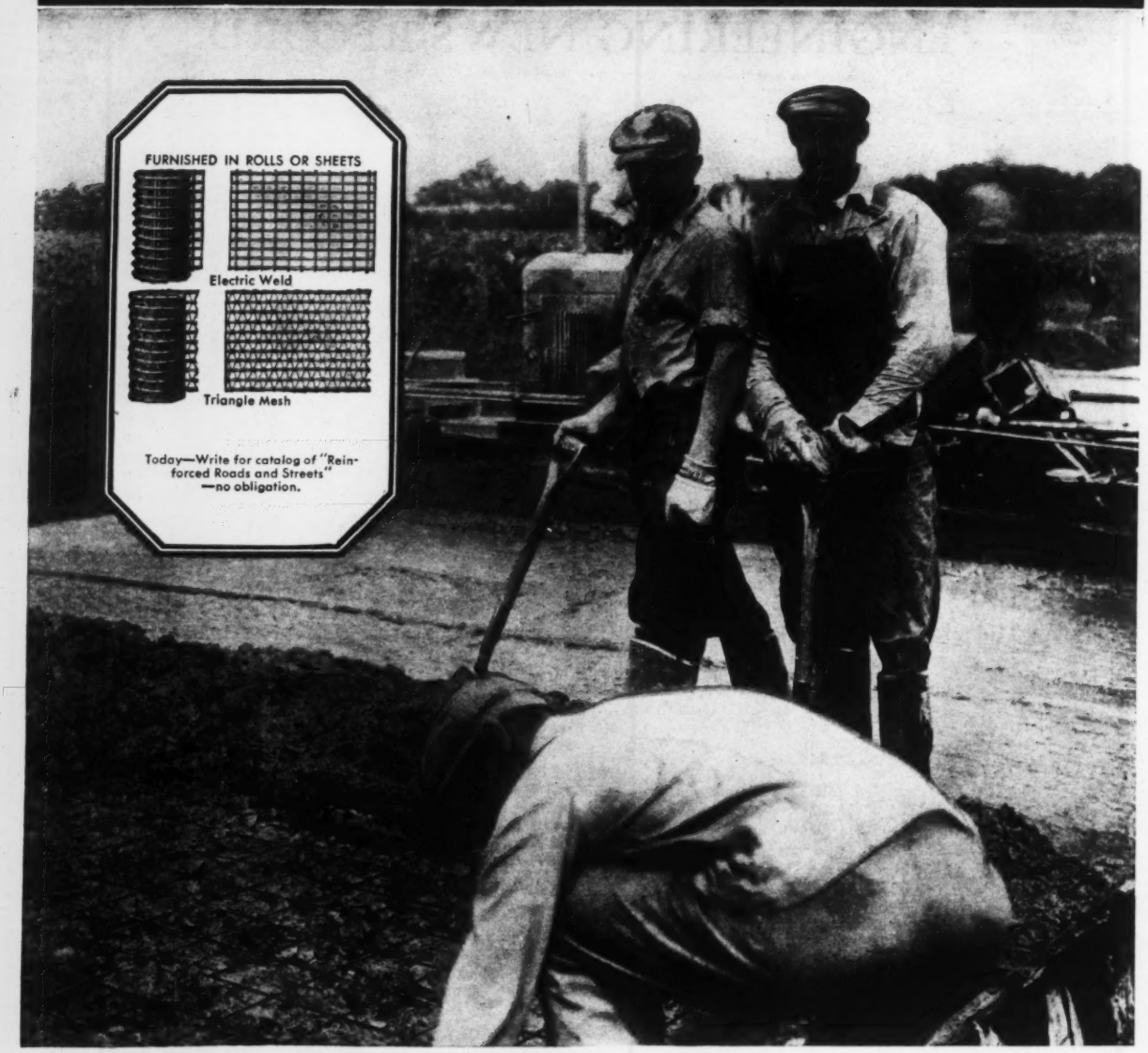
EXCELLENT WORK for utilization of CWA funds has been found by many cities in the relaying of old brick pavements, since it requires a large labor force and a small expenditure for materials. And good serviceable streets have been obtained. An analysis of this type of work from both the procedure and the cost standpoints is presented in this issue.

THE GENERAL CONTRACTORS' CODE went into effect last Monday, putting construction at last under code government. Some of the immediate responsibilities and requirements that confront every contractor are outlined in this issue by the secretary of the Code Authority, and briefly discussed editorially.

Coming Articles:

FOR THE PAST FEW MONTHS we have been soliciting from those in charge of a number of sewage-treatment plants detailed data regarding design characteristics and operating performance. Plant operators have cooperated to a gratifying extent, and detailed figures from a dozen or more installations are now at hand. Beginning with next week's issue, in which will appear an article on Decatur, Ill., there will be published short articles summarizing in tabular form the more salient of these data.

REINFORCED ROADS ARE PERMANENT



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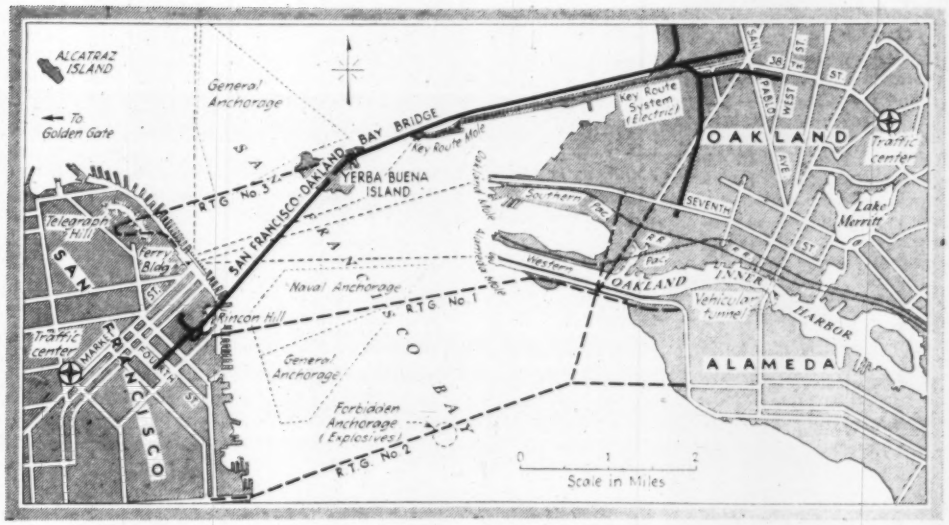


FIG. 1—ROUTE OF NEW BRIDGE over San Francisco Bay, showing also three alternate locations proposed in 1927 by the Ridgeway-Talbot-Galloway board of engineers.

San Francisco-Oakland Bay Bridge

A REVIEW OF PRELIMINARIES

Historic background of the greatest current bridge-building project—Selection and advantages of final site—Financial set-up and traffic estimate—Design considerations, loads and stresses

By C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff

Respectively, Chief Engineer, Bridge Engineer and Engineer of Design, San Francisco-Oakland Bay Bridge

SINCE the days of the California pioneers a bridge to span the water barrier between San Francisco and the communities on the east side of the bay has been discussed and fostered. As early as 1868 the records show that a combined railroad and highway bridge was projected between Hunters' Point, the most easterly land in San Francisco, and the island of Alameda, the westerly limit of the East Bay territory. Such a visionary dream of 65 years ago gradually emerged into the realm of feasibility with the turn of the century, as the growth of the two communities swelled the regular commuting traffic and the development of the automobile added an ever-increasing vehicular traffic. This traffic was served by an extensive ferry system which today handles more than 4,000,000 vehicles and about 50,000,000 passengers per year. The population dependent upon this means of transportation totals nearly 1,500,000. The volume of traffic to be transported across a 4-mile stretch of water between the two sections of this metropolitan area created the demand for the construction of the bridge and, as a corollary, the same traffic made it economically possible.

❖

PROPER APPRECIATION of the factors dictating the final design of the San Francisco-Oakland Bay Bridge necessitates a grasp of its long and involved history. Questions of location, terminals, spans, clearances and financing, common to all bridge projects in some degree, were accentuated on this $75,000,000 project. No previous bridge connected the two populous centers to act as a guide, and it was further generally understood that federal authorities would not look with favor on the building of more than one bridge.

FOR THE PURPOSE of providing an authentic review of the history of the project for those who will wish to follow the subsequent reporting of construction operations, this article has been prepared. It will be followed shortly by a description of foundation design and construction, and the other features will be described as they approach the active stage. —EDITOR.

Early War Department requirements

By 1916 the project had developed to the point of submitting a number of proposals at a War Department hearing. Immediately after the World War interest in the project was intensified, due in large measure to the propaganda of promoters who were seeking a franchise for a private toll bridge. At that time state law vested the granting of the necessary franchise in the Board of Supervisors of San Francisco County.

In 1921 thirteen applicants for a franchise were on record and a War Department hearing was held. On Dec. 1, 1921, the department prescribed the following limitations:

1. No bridge of any kind will be approved north of Hunter's Point.
2. No low bridge will be approved north of San Mateo.
3. A tunnel would be approved at any location if kept below a depth of 50 ft. and if proper provision were made for taking care of the tidal prism.
4. A combined bridge and tunnel would be approved if the tunnel were kept below a depth of 50 ft. and if a 3,000-ft. open channel were left on the San Francisco side, suitable provision being made for the tidal prism where bridge and tunnel join.
5. Not more than one crossing is to be approved at present north of San Mateo.

The situation of the project as it existed in 1925 was outlined in *ENR*, July 30, 1925, p. 178.

The people of the Bay Region were unwilling to accept this decision as final, and an average of one hearing a year was held before the United States district engineer. As interest in the project grew, the number of applications for a franchise increased, so that in August, 1928, there were 38 proposals before the San Francisco supervisors.

A board of engineers, consisting of Messrs. Robert Ridgway, Arthur N. Talbot and John D. Galloway, was retained by the Board of Supervisors to review the situation. The report of the board, filed May 5, 1927 (*ENR*, May 19, 1927, p. 820), contained the following conclusions:

1. The most suitable location is from Rincon Hill to Alameda Mole, with a second choice from Potrero Hill to Alameda Mole, and a third from Telegraph Hill to Yerba Buena Island, thence to the Key Route Mole.
2. The longer spans should be two 1,250-ft. cantilevers.
3. Maximum grades should be 6 per cent for vehicles and 4 per cent for interurban.
4. A double-deck bridge with a 42-ft. roadway on the upper deck and three interurban tracks on the lower deck will provide the desired capacity.

The board stated that "In the absence of vitally necessary information regarding foundations it is not possible to make an estimate of cost that would be of value." It suggested the following plan of procedure for the city authorities: (1) obtain permission from the War Department to build the bridge at location 1; (2) explore the site by borings in order to determine foundation conditions; (3) prepare a proper design, make cost estimates and carry out an economic study of the entire project (*ENR*, May 19, 1927, p. 821).

This report increased public interest, and on July 21, 1927, a delegation headed by Mayor Rolph held a conference with army and navy authorities in Washington, requesting a modification of the prescribed limitations. Their request was rejected in a formal letter from the Chief of Engineers, Oct. 14, 1927. Anticipating this refusal, the Board of Supervisors on Aug. 1 directed the city attorney to prepare a Congressional bill that would provide the necessary permit without the necessity of referring the matter to the War Department. This bill was introduced by Senator Johnson and Congressman Welsh, was favorably reported by the Senate committee but died in the House.

Public ownership idea emerges

Previous to 1927 all proposals were based on private financing. Influenced, doubtless, by the revenue-bond method of financing introduced by the state of Kentucky and followed by the Port of New York Authority, opinion turned in this direction and on Aug. 19, 1921, the Board of Supervisors passed a resolution in favor of public ownership of the bridge. The matter was debated for several months, and out of the discussion came a proposal that the project be turned over to the state of California.

Along with this idea came that of a commission. As a result of discussions between President Hoover and B. B. Meek, director of public works, representing Gov. C. C. Young, the President announced on Sept. 25, 1929, the appointment of the Hoover-Young San Francisco Bay Bridge Commission. The appointees were Mark L. Requa, chairman; George T. Cameron, Rear-Admiral Luther E. Gregory, Rear-Admiral W. H. Standley, Brig.-Gen. G. B. Pillsbury, Lt.-Col. E. H. Daley, Arthur H. Breed, Charles D. Marx and C. H. Purcell.

The move for state control of the project resulted in the California Toll Bridge Authority Act at the 1929 session of the legislature. The act decreed as follows:

1. Declared it the policy of the state to acquire all existing toll bridges.
2. Amended the law so as to vest the power to grant franchises for private toll bridges in the department of public works.
3. Created the Toll Bridge Authority, a board consisting of the governor, lieutenant governor, director of public works, director of finance and the chairman of the highway commission.
4. Designated the department of public works as the agent of the commission to design, construct and operate toll bridges.
5. Provided for the financing of the construction by the sale of revenue bonds.
6. Appropriated a revolving fund of $50,000 for preliminary investigations.

The same legislature also authorized the California Toll Bridge Authority to "lay out, acquire and construct a highway crossing from the city of San Francisco to the county of Alameda."

Hoover-Young Commission studies

The Hoover-Young Commission convened at Sacramento, Oct. 7, 1929, to review the general problem and formulate a method of procedure. Former reports and available data were considered. It was evident that before the problem could be intelligently considered by the commission, engineering data on location, traffic, foundations and costs would have to be obtained. The commission requested the department of public works to investigate these matters fully and render a report. C. H. Purcell, state highway engineer and secretary of the Hoover-Young Commission, was assigned the general supervision over this investigation and report. C. E. Andrew, bridge engineer, division of highways, was placed in immediate charge of the study. Limited funds were available; a revolving fund of $50,000, set up for the use of the Authority, provided $24,000; San Francisco appropriated $40,000, and Oakland provided $4,000.

The initial step in the investigation was to select four general crossing locations and make preliminary borings. This work provided data on general foundation conditions over an extensive area of the bay, including all feasible bridge sites. At the same time a traffic study was started under the direction of Lester Ready, consulting engineer, San Francisco, including an actual origin-destination count, supplemented by a compilation of former traffic counts and ferry records.

On the basis of these data preliminary engineering designs and estimates of cost were prepared. It was evident almost immediately that the location from Rincon Hill, San Francisco, to Yerba Buena Island and continuing east to Oakland was best from a consideration of both cost and traffic requirements. The 10,000-ft. channel crossing between San Francisco and the island presented the most difficult problem in design, and the considerations which led to the gradual evolution of the structure now being erected are reviewed later in the article.

Briefly, the plans and estimates, based on preliminary studies of both cantilever and suspension layouts on the proposed route (using Yerba Buena Island) as well as on three other locations, together with traffic data and financial reviews, were incorporated in a report to the Toll Bridge Authority for a meeting in July, 1930. Several changes in the clearances provided were required by the War Department engineers, and as a result the original cost estimate of $72,000,000 was increased to $75,000,000. With these changes in design, the Hoover-Young Commission adopted this report and made the following recommendations Aug. 6, 1930:

1. To meet the present and future needs of the several communities, a crossing for traffic between San Francisco and the East Bay cities is necessary.
2. Consistent with meeting the traffic needs and engineering requirements, the type and location of a bay crossing should be such that it will not unreasonably obstruct future navigation nor cause serious interference with or constitute a serious menace to the operations of the navy in time of war.

3. Because of the limitations, cost of construction and operation, a vehicular tunnel under the bay is inadvisable.

4. As indicated by the rock explorations, the only location upon which to base a high-level bridge is on a line from Rincon Hill to Goat Island.

5. A bridge on the location designated as Location No. 4, from Rincon Hill via Goat Island, thence parallel to the Key Route Mole, is practicable from an engineering standpoint. It is economically feasible under a proper fiscal plan and will adequately serve the needs of trans-bay traffic.

6. The bridge shall provide at least six lanes for vehicular traffic and in addition five lanes for interurban and heavy automobile-truck traffic.

7. The bridge between San Francisco and Goat Island shall consist of not more than four main spans, the westerly one of which shall have a horizontal clearance of not less than 1,750 ft. between fenders.

8. The vertical clearance of the two center spans shall be not less than 214 ft. above m.h.h.w. at the center of the spans, and this height shall be maintained for about 500 ft. on either side of the center of the span; the minimum vertical clearance at the San Francisco pierhead line shall be 180 ft. above m.h.h.w.

9. The main channel span in that portion of the bridge between Goat Island and the east shore shall have a minimum vertical clearance of 180 ft. above m.h.h.w. and a minimum horizontal clearance of 600 ft. between fenders. Consideration should be given in the final plans to a minimum clearance of 700 ft. between fenders.

10. The final design should be such that it will conform with the scenic beauty of San Francisco Bay.

11. The details of construction of the bridge structure are the function of the state of California working through the California Toll Bridge Authority.

12. Consideration of traffic distribution on both sides of the bay is of prime importance and should be worked out in cooperation with the authorities of the municipalities in interest.

13. A right-of-way across Goat Island must be obtained from the Navy Department and be approved by Congress.

14. Under the provisions of the federal law after legislative authorization by the state of California, the plans of the bridge must receive the approval of the Chief of Engineers, War Department, and of the Secretary of War before construction is begun.

15. The legislative authority of the state for the construction of the bridge is vested in the California Toll Bridge Authority. In order that the bridge may be constructed, it is necessary that the Bridge Authority authorize and direct its construction.

Suspension spans studied

The 1931 legislature appropriated $650,000 for preliminary surveys and designs. The bridge department of the division of highways immediately began more detailed design studies, particularly on the possibility of a suspension-bridge layout for the west channel. This resulted from the opinion of the commission that wider horizontal clearances were desirable than could be provided by a cantilever design. The studies included a twin suspension span, including the use of a central anchorage and a continuous suspension-span layout. Designs were worked out for both of these types, and in June, 1931, Prof. G. E. Beggs, Princeton University, was retained to make models of these two designs in cooperation with Prof. R. E. Davis at the University of California. The model study checked the design of the department, proving the superiority of the central anchorage type. This layout was also favored at early conferences with Ralph Modjeski, chairman of the consulting board, appointed Aug. 15.

In August, 1931, C. H. Purcell was made chief engineer of the project, and Chas. E. Andrew was appointed bridge engineer of the Toll Bridge Authority. The following month a San Francisco headquarters was established and further detail design work was begun under the immediate direction of Glenn B. Woodruff, engineer of design.

RFC financing

During this period of design preparation the Reconstruction Finance Corp. came into existence, and an application was made to that body for the purchase of the bonds to finance the project. On Dec. 15, 1932, the RFC agreed, subject to (1) additional state legislation, (2) a test of the legislation in the State Supreme Court and (3) state financing of the approaches, to purchase bonds up to a limit of $61,400,000. These conditions were met, and on April 27, 1933, the RFC confirmed this offer. Contracts for the six major parts of the work were awarded April 28. (For list of bids see *Engineering News-Record*, March 23, 1933, p. 393.)

Bridge location

The Ridgway-Talbot-Galloway report recommended, in order of preference, the three locations designated on the map (Fig. 1) as R.T.G. 1, R.T.G. 2 and R.T.G. 3. The location finally adopted was selected by the Hoover-Young Commission, and it best meets all the requirements.

Market St., the Broadway of San Francisco, lies midway between two high points, Telegraph Hill to the north and Rincon Hill to the south. To avoid street congestion and excessive property values, as well as to reduce the construction cost of approaches, it was necessary to land on one of these points. The street system south of Market St. affords better distribution than the street system from Telegraph Hill.

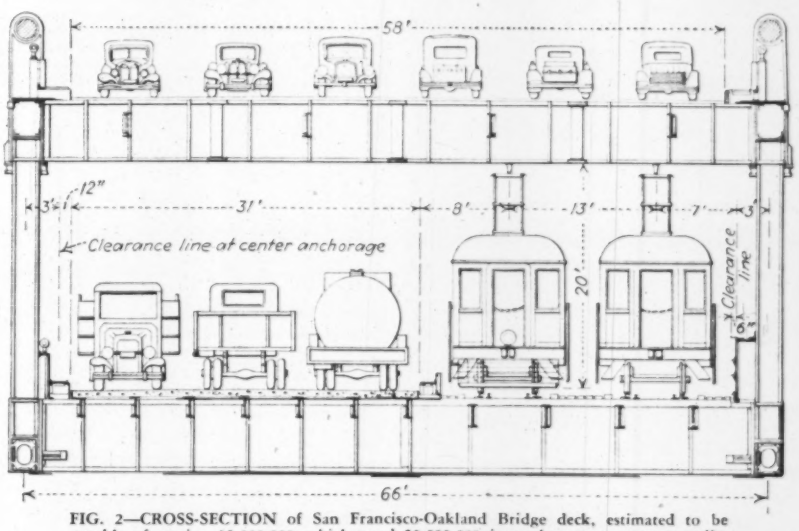


FIG. 2—CROSS-SECTION of San Francisco-Oakland Bridge deck, estimated to be capable of serving 25,000,000 vehicles and 50,000,000 interurban passengers annually.

Moving the bridge as far south as practicable gives the least possible interference with navigation. Furthermore, the trend of San Francisco's development is to the south. For these reasons the Rincon Hill location was chosen for the San Francisco terminal.

The city of Alameda is situated on an island separated from the other East Bay cities by a navigable estuary. A bridge terminating in Alameda would require a high-level crossing over or a tunnel under this waterway and lead bride traffic directly into the congested business center of Oakland. Furthermore, a bridge on this location would have crossed the naval anchorage, a proposal not acceptable to the navy.

The location finally adopted has its main East Bay terminal at 38th and San Paolo Sts., Oakland, a short distance north of the business center. This terminal is in a direct line with the boulevard on the east side of the bay, which connects with the main highway into the San Joaquin Valley and also connects with Broadway, Oakland, which leads to the proposed new tunnel into Contra Costa County. There is a proposal for an east shore highway from San Jose to Albany which will bypass

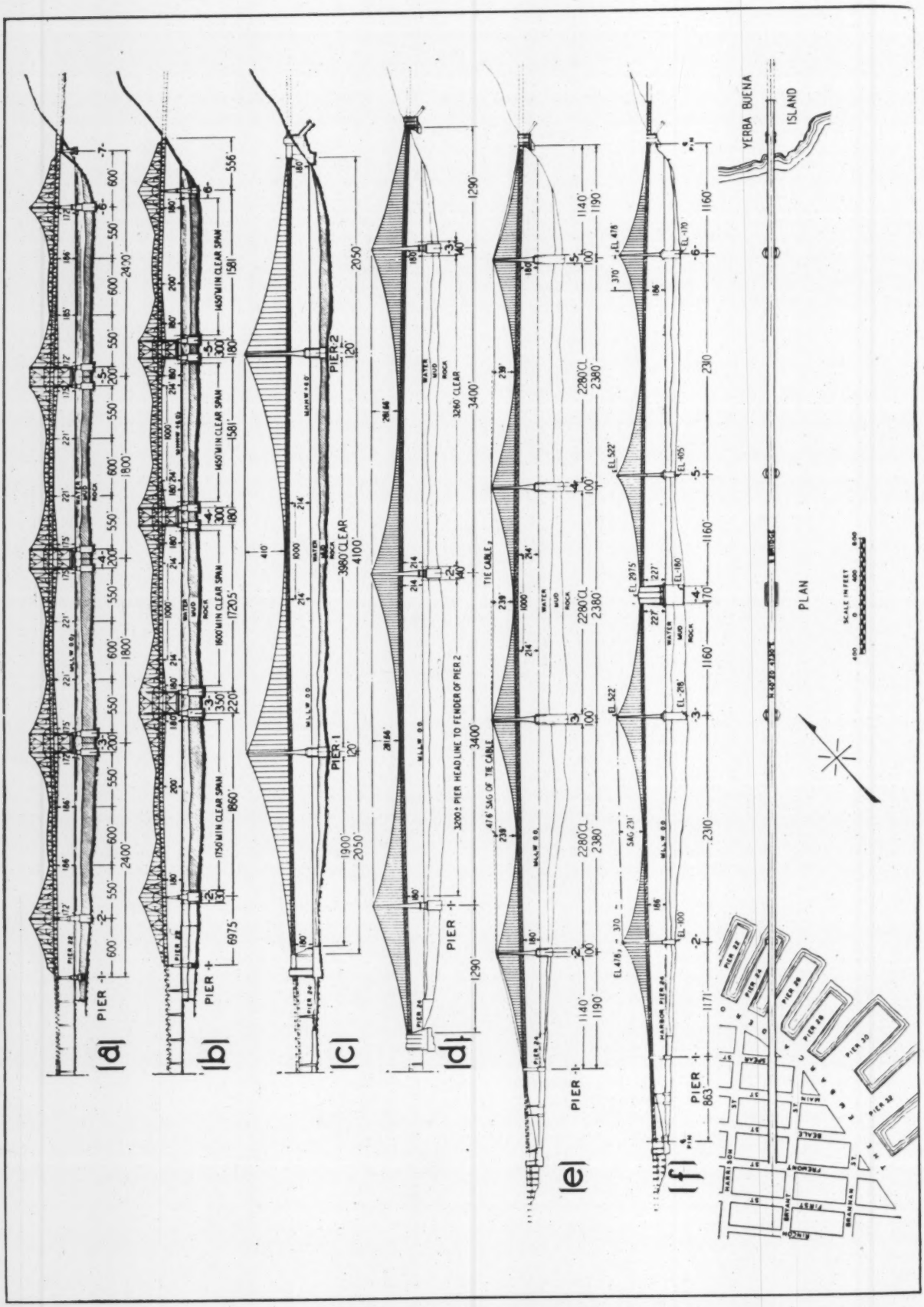


FIG. 3—WEST BAY CROSSING—ALTERNATE LAYOUT STUDIES.

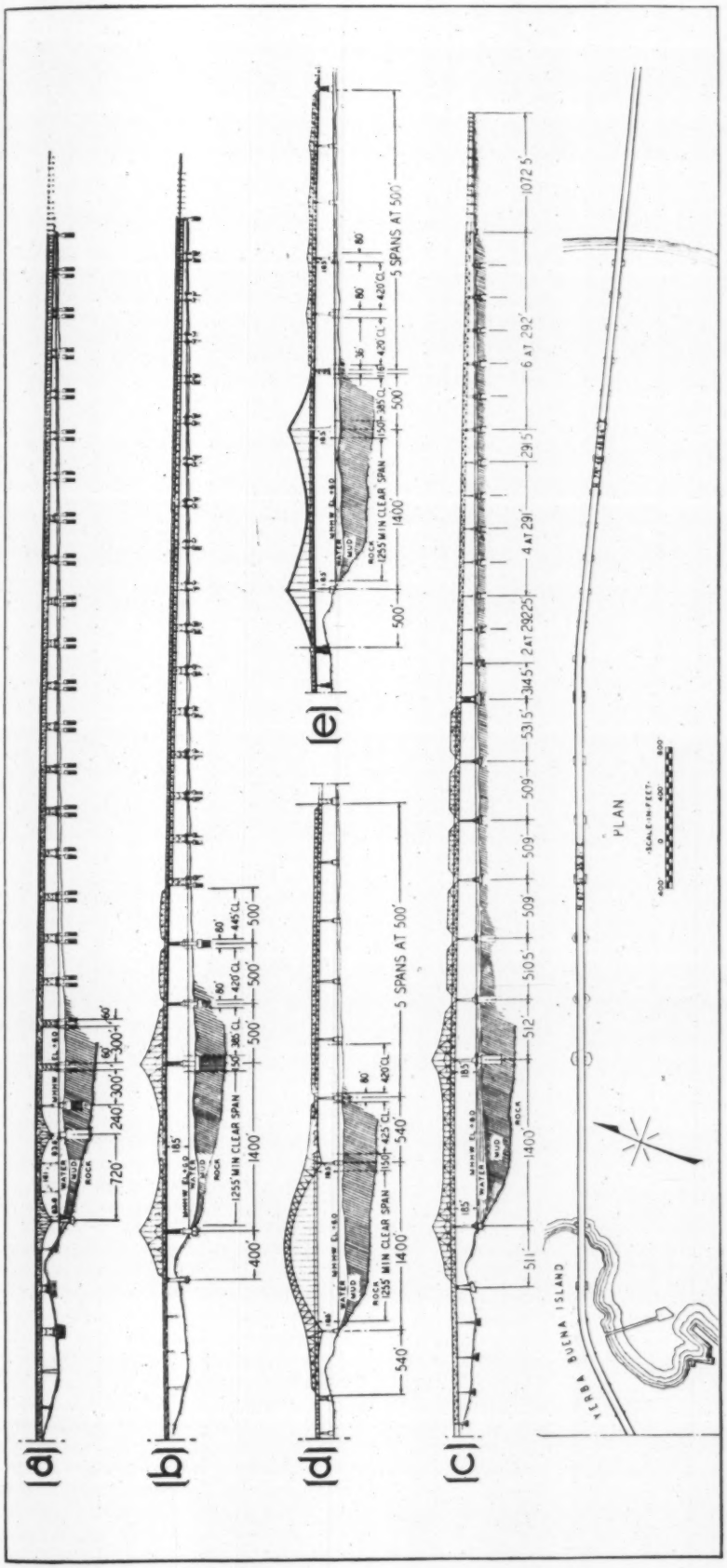


FIG. 4—EAST BAY CROSSING—ALTERNATE LAYOUT STUDIES.

all congested districts. It was found possible to connect this future traffic artery into the bridge approaches and, as part of such approaches, construct the first link, so as to extend from Seventh St. in Oakland, to Ashby Ave. in Berkeley.

In making the traffic studies for the Hoover-Young report, the areas on both sides of the bay were divided into the districts shown on the map, and the origin and destination of both vehicular and interurban traffic were plotted as follows:

The adopted location: (1) joins the centers of gravity of this traffic in a nearly direct line, (2) bypasses and at the same time provides ready access to the business centers and (3) is capable of extension as traffic may develop.

The available information as to rock elevations is given on the illustrations of alternate layout studies, Figs. 3 and 4. On the adopted line, foundation conditions are at least as favorable as at any other possible location.

Economics

The record of trans-bay traffic from 1920 to 1932 with estimates of future traffic is shown in the accompanying table on p. 376.

Under usual conditions it would have been sufficient to have provided facilities for an annual traffic of 15,000,000 vehicles and 50,000,000 interurban passengers, requiring a six-lane roadway and two interurban tracks. In this case, however, there seemed to be a feeling, and the military members of the Hoover-Young Commission have insisted, that the present project should be the only crossing to be built north of Hunter's Point. There was, therefore, a tendency to build farther into the future than would otherwise be advisable.

In studying matters of interurban operation it was considered desirable to have the two tracks side by side, so that cross-overs could be provided at frequent intervals. This eliminated the possibility of carrying the interurban on brackets with the vehicular roadway between the trusses. To accommodate two interurban tracks and six traffic lanes on one deck would have required a width between trusses 30 ft. greater than that finally adopted. Such a width would have greatly increased the cost of the floor system and the substructure. By using a double-deck design the economics of restricting the weight of vehicles on the upper deck could be gained, so that the extra three traffic lanes are being obtained at little additional cost.

The double-deck cross-section shown in Fig. 2 was therefore adopted. It is estimated by the designers to have a capacity of more than 25,000,000 vehicles and 50,000,000 interurban passengers annually.

The estimated cost of the structure

ready for operation is $76,000,000, divided as follows:

VEHICULAR BRIDGE		
Construction	$48,600,000	
Property	3,600,000	
Engineering and administration	3,200,000	
Insurance, etc.	500,000	
Interest	6,000,000	
		$61,900,000
INTERURBAN FACILITIES		
Construction	4,800,000	
Equipment	4,500,000	
Property	4,800,000	
Engineering	600,000	
Interest	1,000,000	
		$15,700,000
Total cost		$77,600,000

FINANCING	
State of California (from gas tax)	$ 6,600,000
RFC (loan granted)	61,400,000
RFC (loan applied for)	15,600,000
	$83,600,000

The discrepancy between the estimated construction cost and the total financing is accounted for by the fact that, while the RFC has allotted funds to the extent of $61,400,000 for the vehicular bridge, it is anticipated that $6,400,000 of this amount will not be required. The annual charge on the structure for the first five-year period is estimated as:

Interest	$3,550,000
Operating and maintenance	550,000
	$4,100,000

The interest is based on a total expenditure of RFC funds of $71,000,000. In estimating revenues it has been assumed that 75 per cent of all vehicles crossing the bay would use the bridge, the remainder being carried by the ferries. The average toll has been assumed at 75c. per vehicle and 2c. minimum per interurban passenger. The first-year revenue would therefore be:

6,000,000 vehicles @ 0.75	$4,500,000
35,640,000 passengers @ 0.02	712,800
	$5,212,800

The RFC made it a condition of its loan that all revenues be applied to debt service and use and occupancy insurance, all operating charges and maintenance to be paid by the state.

Design considerations—West Channel

The development of the layout and design for the 10,000-ft. West Channel crossing between San Francisco and Yerba Buena Island provided such a variety of possibilities that the result was a distinct evolution. Although it is impossible to consider the large number of tentative designs that were made, some of the typical studies that formed the basis for final comparison are indicated in Fig. 3 (*a*) to (*f*).

Included in the preliminary layouts studied under the direction of the highway department were: (1) a four-span symmetrical cantilever; (2) a two-span suspension bridge with cross-cables and a central arch at the center of the channel. (Considerable attention was given to this layout, but the plan was abandoned because of the cost.) (3) a two-span simple suspension bridge with central anchorage for live loads; (4) a three-span continuous suspension bridge with tower ties; (5) a four-span continuous suspension bridge with tower ties. Completion of preliminary plans for these various design types was impossible at the early stage of the work (prior to the establishing of the final engineering organization) because of lack of time and funds.

Since the four-span symmetrical cantilever (minimum number of spans permitted by War Department rulings) was feasible and provided the shortest allowable channel clearances, it was decided to concentrate on this layout for the purpose of obtaining the requirement permits. The result would be to obtain permission for the minimum channel clearances with the possibility of subsequent increase in span length if another design were found desirable. As provided in the final report of the Hoover-Young Commission, this design is shown in Fig. 3 (*a*). The demands made by the navigation interests for more generous clearances were met in plan (*b*) and the final permit was issued on this layout, Jan. 19, 1932.

Even during the final steps of securing approval for the cantilever layout, the engineering thinking had turned to a suspension design as the more logical answer to the problem. The advantages included lower cost, fewer construction hazards and more pleasing appearance. The length of crossing required consideration of the following alternates: (1) conventional suspension type with 4,100-ft. main span (*c*); (2) multiple-span layout (*d*) or (*e*); and (3) central anchorage design (*f*).

The 4,100-ft. span presented strong temptations. It required fewer departures from past practice than any alternate layout, reduced the number of piers to be constructed and was a more monumental structure. On the other hand, it was open to the following objections:

1. The difficulties of building the San Francisco anchorage. An open cofferdam, 100x250 ft. in plan, constructed to El. —120, would have been required.

2. While investigations indicated that it would be possible to secure the necessary transverse stiffness with a width of 72 ft. c. to c. of trusses, a large amount of stiffening-truss material would have been required to resist wind stresses.

3. It did not provide as much clearance in the main steamship lane between the pier-head line and the first pier as does the adopted design.

4. The construction west of the anchorage involved the destruction of two harbor piers.

5. The construction cost was estimated at $3,000,000 higher than the adopted design.

The model tests (*ENR*, June 9, 1932, p. 828)* demonstrated that the two-span continuous layout (*d*), even with a sag ratio of 1:12, was too flexible to be satisfactory. For this reason no design studies were made of this layout.

It was obvious that a center anchorage for a dual-span design would be very expensive. A caisson, unprecedented in size, was involved, and the cable details at the top of the center anchorage presented new problems. As a result, considerable study was given to a multiple-span design, studies being made with tie cables and also with a less flexible stiffening truss. Some study was also given to a braced chain, using eyebar cables.

For a bridge with vehicular loads only and assuming probable conditions of unbalanced loads, multiple spans, either with or without the tie cables, have great possibilities. With the interurban loadings it was difficult to secure

*For a complete description see "Tests on Structural Models of Proposed San Francisco-Oakland Suspension Bridge," University of California Press.

TRANS-BAY TRAFFIC—SAN FRANCISCO TO OAKLAND

Year	Vehicles	Passengers Vehicular	Passengers† Interurban	Total
1920	773,294	2,609,982	39,653,420	42,263,4[illegible]
1921	828,782	2,818,047	38,654,822	41,472,8[illegible]
1922	934,545	2,746,982	38,660,658	41,425,6[illegible]
1923	1,224,936	3,270,124	40,760,000	44,030,3[illegible]
1924	1,342,968	3,463,769	41,284,593	44,748,3[illegible]
1925	1,558,636	4,085,509	41,481,683	45,567,1[illegible]
1926	2,707,066	6,706,670	38,948,571	45,655,2[illegible]
1927	3,536,781	8,274,464	38,274,653	46,549,4[illegible]
1928	4,150,466	9,611,117	36,981,585	46,592,7[illegible]
1929	4,490,513	10,174,028	35,923,855	46,097,8[illegible]
1930	4,631,414	10,588,020	34,406,614	44,994,6[illegible]
1931	4,518,552	10,470,439	31,872,753	42,343,1[illegible]
1932	4,183,816	9,423,009	28,001,106	37,424,1[illegible]
1933	4,500,000	10,200,000	32,000,000	42,200,000
1934	4,860,000	10,700,000	32,000,000	42,700,000
1935	5,360,000	11,500,000	32,000,000	43,500,000
1936	5,725,000	12,200,000	32,000,000	44,200,000
1937	8,000,000	16,000,000	35,640,000	51,640,000
1938	8,355,000	16,710,000	35,850,000	52,560,000
1939	8,710,000	17,420,000	36,000,000	53,420,000
1940	9,060,000	18,120,000	36,150,000	54,270,000
1941	9,410,000	18,820,000	36,300,000	55,120,000
1942	9,765,000	19,530,000	36,485,000	56,015,000
1943	10,120,000	20,240,000	36,635,000	56,875,000
1944	10,480,000	20,960,000	36,865,000	57,825,000
1945	10,840,000	21,680,000	37,160,000	58,840,000
1946	11,200,000	22,400,000	37,536,000	59,936,000
1947	11,555,000	23,110,000	38,074,000	61,184,000
1948	11,910,000	23,820,000	38,600,000	62,420,000
1949	12,265,000	24,530,000	39,300,000	63,830,000
1950	12,620,000	25,240,000	40,000,000	65,240,000

†Includes passengers crossing bay from railroad main lines.

the desired rigidity. A connection at the saddle castings to transfer the stress from the tie to the main cables and anchor the main cables beyond possibility of slipping made an unwieldy detail. It soon became apparent that the cost of tie cables or of extremely deep stiffening trusses would at least offset the cost of the center anchorage.

Adopted west crossing design

Early in 1932 we presented these studies to the consulting board which had been appointed, and unanimous agreement was reached on the outline of the final design (*f*). This involves two complete suspension bridges, the structure being symmetrical about the central anchorage except for the difference at the San Francisco and Yerba Buena anchorages. The first designs were made on the basis of a "high" anchorage at the San Francisco end of the suspended structure. Foundation explorations disclosed that rock satisfactory for an anchorage foundation at this location was very deep, resulting in a difficult foundation problem. Secondly an inclined backstay was used and the anchorage moved back 800 ft.

In final design the principal features of the West Channel crossing include: two 2,310-ft. suspension spans with 1,160-ft. side spans supported by 28.75-in. diameter cables. The superstructure design of these twin suspension spans involves no outstanding departure from previous practice, although many new details have been developed. The structural-steel towers rise to El. 520 from concrete piers with tops at El. 40. All of the piers rest on bedrock, and three will be sunk as caissons by dredging. The common central anchorage is 97x192 ft. in plan at maximum section, extends from El. —180 to El. 295 and will support the unbalanced live load from the two spans. A gravity type of anchorage is provided at the San Francisco end and a tunnel anchorage will be provided on the island.

East Bay crossing

The various span layouts proposed for the East Bay crossing are shown on Fig. 4 (*a*) to (*e*). Diagram (*a*) indicates the structure recommended by the Hoover-Young Commission. Objections were made to the proposed clearances, and a War Department permit was issued on Jan. 19, 1932, approving the structure shown by diagram (*b*). The structure under contract is shown by diagram (*c*). Diagrams (*d*) and (*e*) indicate alternate studies made for the main channel, in an effort to obtain a more pleasing appearance.

The controls of this design were very interesting. The rock falls off rapidly to the east from Yerba Buena Island. At Pier E-3, the east support of the main cantilever span, rock is 290 ft. below water. Sand and gravel strata capable of sustaining vertical loads overlie the rock, but it is difficult to secure anchorage against horizontal forces. For this reason, not only was a suspension design impracticable but it was expensive to secure sufficient anchorage for the longitudinal forces due to wind and earthquake on the adopted layout. This led to a design with an extremely long distance between the expansion joints. The cantilever structure is anchored at Pier E-1, the 509-ft. spans at E-9, and provision for the expansion of 20 in. each way from normal over the intervening distance of 5,000 ft. is being made at Pier E-4.

To keep the vertical loads as low as possible, the spans are, in general, supported by flexible steel columns rather than by masonry pier shafts, the top of concrete being at +40 for Piers E-2 and 3, at +30 for Piers E-4 and 5 and at +25 for the other piers. This arrangement made it possible to provide for longitudinal expansion by the bending of the towers in place of the usual roller details.

MATERIALS AND BASIC UNIT STRESSES

Steel Material	Ultimate Strength, Minimum	Yield Point, Minimum	Unit Stresses—Tension	Unit Stresses—Compression
Medium carbon	62,000	37,000	22,000	22,000-70l/r
Silicon	80,000	45,000	28,000	28,000-90l/r
Nickel	85,000	55,000	34,000	34,000-110l/r
Heat-treated eyebars	80,000	50,000	34,000	
Cable wire	220,000	150,000	82,000	

A 1,400-ft. cantilever span

The principal feature of the crossing is the 1,400-ft. cantilever span, ranking third in length for this type of structure. The crossing is completed by five 509-ft. and fourteen 291-ft. truss spans. The curved alignment was necessary to avoid interference with the Key Route terminal. Piers E-3, 4 and 5 are cellular concrete caissons, the first being 80x134.5 ft. in plan with its cutting edge at El. —220 and a seal extending 10 ft. deeper. Piers E-4 and 5 have their cutting edge at El. —170. Piers E-6 to E-22 are supported on piles with the base of seal at El. —50.0, the piles penetrating to El. —115.0. Pier E-9 contains 625 piles spaced at 4-ft. centers, the base of this pier being about 100 ft. square.

Factors controlling design

The controlling thought throughout the work has been to provide a self-liquidating project. Therefore, from the start it has been apparent that the total capital investment must be kept within $75,000,000. From the comparative dimensions of this and similar projects, it was evident that the design must be as economical as consistent with the necessary facilities and sound engineering practice. It was also evident that there were no funds available for elaborate architectural treatment, although throughout the design every effort has been made to secure pleasing proportions. All possible effort has therefore been given to securing a design that would require a minimum of maintenance.

For these reasons the principle of assuming ultimate live loads and designing on the basis of dead-load unit stresses was adopted, although, considering the materials used, the resulting unit stresses are less than permitted by many specifications.

Design loads

Although it is planned to restrict the upper deck to passenger vehicles, the floor is designed on the basis of a 10-ton truck at any point of the roadway and six lanes simultaneously loaded with H-6 loading. The lower deck is designed on the basis of three lanes of H-30 loading and two lines of 70-ton interurban cars, a factor 85 per cent being used when all lanes are loaded. Impact was assumed at 33 per cent for short spans, the percentage decreasing with length of span. The trusses are designed for a live load of 7,000 lb. per lin.-ft. of bridge plus concentrations of 150,000 lb. for moments and 260,000 lb. for shear. Wind has been assumed as 30 lb. per sq.ft. on 1½ times the vertical projection of the structure plus a transverse force of 500 lb. per lin.-ft. on the live load. The same force is assumed to act at an angle of 45 deg. with the bridge axis. Earthquake acceleration is assumed at 10 per cent of gravity.

The materials and basic unit stresses are specified above in lb. per sq.in.

Personnel

The project is being constructed under the auspices of the California Toll Bridge Authority consisting of: James Rolph, Jr., governor, F. Merriam, lieutenant-governor; Earl Lee Kelly, director of public works; Rolland A. Vandegrift, director of finance; and Harry A. Hopkins, chairman, state highway commission.

The department of public works is charged with the design, construction and operation of the project. A separate division of the department was set up for this purpose, with Charles H. Purcell, state highway engineer, as chief engineer; Charles E. Andrew as bridge engineer, Glenn B. Woodruff as engineer of design, and J. R. Kelsey as assistant engineer of design. A board of consulting engineers consisting of Ralph Modjeski, Moran and Proctor, L. S. Moisseiff, Chas. Derleth, Jr., and H. J. Brunnier was selected to advise on all phases of the work. Messrs. Arthur Brown, Jr., T. L. Pflueger and John Donovan were appointed consulting architects.

Relaying Brick Pavement With CWA Labor

Survey shows many operations carried out at total costs greater than normal but at low costs to the cities where the work was done

By Geo. F. Schlesinger
Engineer-Director, National Paving Brick Association, Washington, D. C.

WHILE it would be no exaggeration to say that hundreds of brick pavements, 25 years or more old, had been relaid in the past decade, this type of paving improvement has attained culminal proportions in the CWA program of work relief. Its adaptability to the objectives sought is apparant; taking up, cleaning and relaying paving brick are purely hand-labor jobs. Accordingly, the Middle Western section of the U.S.A. has been echoing to the sound of hammer and tamp on paving brick that were produced in a previous generation.

Some brick are broken in cleaning, others in removing and handling, while a few are not worth reclaiming. But the new brick required usually runs less than 20 per cent. In some cases, brick that were laid originally on edge are relaid flatwise with the resulting gain in area. There are actual instances of surplus brick being used for additional paving. If the old base is adequate or properly repaired, and other details of construction, such as bed course and filling, receive the same attention as in new construction, the results are comparable to a new brick surface. Due to increased costs of materials the relaid brick are worth more now than was paid for them originally.

In view of the many current beliefs of the lack of investment value generally of the work being done under the CWA, a practice and cost analysis of this particular class of work has interest. A complete census, it can be announced at once, is not possible, but a survey of a group of operations selected as fairly representative is practicable, and, it is believed, presents a reasonably true picture.

In presenting any data of volumes of work under way it will be understood that the figures are as of the date the information was obtained. The disposition of CWA operations is changing too rapidly for any figures of volume to be fixed for any considerable period of time. Three groups of operations, in Ohio, at Pittsburgh and at Chicago, have been selected as examples.

In Ohio G. J. Kane, chief engineer of CWA work for the state, reported that the total number of brick-relaying projects under way was 144, and involved work in 42 counties. The estimates indicated that about 19,000 men were employed with a total wage of about $3,000,000. The work principally consisted of turning the old brick, of paving car-track center strips and of a small amount of widening. The amount of new brick required for these projects was about 7,000,000, and the square yards of all types of work involved was about 1,142,196.

Mr. Kane's figures indicate an average salvage of more than 80 per cent. In addition to the CWA program, considerable brick relaying is included in the NRA federal projects under the direction of the Ohio department of highways. From Pittsburgh T. J. Mitchell, district engineer, National Paving Brick Association, advised on Jan. 29 that in the Pittsburgh district about 300,000 to 350,000 sq.yd. of old brick pavements relaid under the CWA program would be completed in the next 30 days. Conservative estimates indicated that about 800,000 new brick had been required, which showed the salvage value of the old brick to be 75 to 80 per cent.

According to Joseph J. Butler, superintendent of streets, Chicago, the city had 86 gangs working on this type of improvement on Feb. 7, 1934, under the direction and supervision of the CWA. The primary purpose had been to employ as many men as possible; consequently, the cost per square yard had been high, but was gradually being reduced as the organization was perfected. The percentage of salvage of old brick varied greatly with the condition of the old pavement, but on the whole it was very high.

Examples of cost

As the removing, cleaning and replacing of the old brick are entirely labor items, the cost will vary with the wages paid and the efficiency of the labor. The cost of cleaning is also dependent upon the type of filler used in the original construction; the extreme conditions would be represented by a sand filler and a rich cement-grout filler.

CLEANING old brick and relaying them by CWA labor in Wooster, Ohio. Part of the old pavement was laid in 1892 and part in 1905.

Cost of relaid brick pavements complete have ranged from 50c. to $1 per square yard. With the labor rates and conditions obtaining in the CWA work, the cost has been somewhat greater. A carefully analyzed CWA operation reported by J. E. Fox, city engineer, Wooster, Ohio, presents methods and costs as follows:

The first project selected by the city of Wooster, under CWA, was the repairing of North Buckeye St., from Liberty St. to Bowman St., 7,543 sq.yd. of brick pavement. The first block undertaken was from Liberty St. to North St. and contained 2,875 sq.yd.; the remainder was from North St. to Bowman St. and contained 4,668 sq.yd. The first block was paved in 1892, with plain wire-cut fire clay brick, 2½x4x9 in. The second section was paved in 1905 with repressed shale brick, 3x4x8¾ in. There was nothing but the natural soil for foundation and some gravel that had been used to make a bed for laying the original brick.

Naturally the street was in very rough condition after all these years of service, so that, after the brick were taken up and cleaned, the foundation was leveled up and rolled and, where necessary, gravel was used to fill up all large depressions. After rolling and preparing the base, granulated slag was applied as a cushion for the brick. Due to the wear of the brick, it was decided to lay them flatwise, which gave a smoother surface with less labor. In relaying the brick an expansion joint was used every 25 ft., which was filled with asphalt; also 2 ft. from each curb line an asphalt filler was used, and the rest was cement-grout filler with 1 to 3 mix. The work was started Nov. 27, 1933, and was completed for traffic Jan. 22, 1934. The following is a résumé of the cost:

Cost to Wooster for material...	$1,428.35
Cost to Wooster for labor, engineering and equipment.....	548.53
Total cost to Wooster.....	$1,976.88
Paid from CWA funds, 9,983 hrs. labor	5,289.88
Total cost for 7,543 sq.yd..	$7,266.76
Total cost per sq.yd...	$0.9633
Cost to Wooster per sq.yd.	$0.2621
Cost to C.W.A. per sq.yd.	$0.7012

When North Buckeye St. was paved in 1905, it cost the property owner $2.60 per linear-foot assessment, and, if the same rate of assessment were now made on the above work, it would be $1.11 per linear-foot. It is considered by Mr. Fox that this pavement is in better condition today than when originally laid. The base, after 30 to 40 years of traffic, cannot help being better. The granulated slag cushion is an improvement over the original cushion, and the brick as now laid will give at least as much service as they have in the past. It is interesting to note that, after the completion of this project, about 20,000 brick were left over that may be used for repairing alleys and sidewalks.

Saddle-Back Bins on Tractor Handle Dried Sewage Sludge

Springfield, Ill., finds flexibility and low unit weight of crawler machines an advantage over fixed tracks

By W. B. Walraven
Engineer, Springfield Sanitary District, Springfield, Ill.

At sewage-treatment plants using sand sludge-drying beds, the removal of the dried sludge presents a troublesome and almost continuous problem. At the different plants the process of removal varies considerably. Some plants employ trucks that run upon fixed or movable runways, while others use industrial railway equipment. A few, particularly the very largest plants, have tried the development of specially designed sludge-stripping mechanism.

At the sewage-treatment plant of the Springfield Sanitary District, sludge was, until recently, removed in trucks that ran upon tracks composed of heavy oak planks. The placing and removal of these planks entailed a considerable amount of labor, and they were not wholly satisfactory. Sometimes the trucks ran off the planks, with the result that the sand beds became badly cut up. Estimates were made comparing the cost of fixed runways of concrete or steel channel with industrial railway equipment. The officials had almost decided to build fixed steel tracks when an entirely new idea was presented.

A tractor manufacturer suggested a crawler-type tractor upon which side-dump sludge bins could be mounted. After a few weeks' study of the problem, the company's engineer offered designs for bins to hold 2¼ cu.yd. of sludge, equally divided between the two sides and provided with dumping levers that can be operated from the driver's seat. The superimposed load added to that of the weight of the tractor results in a uniform pressure of 10 lb. per sq.in. under the surface of the crawlers in contact with the sand. The loading edges of the bins are 3½ ft. above the sand.

Experience with the machine has been satisfactory, and it has been particularly pleasing to note that the crawlers cause very little disturbance or compacting of the sand bed. Due to the extreme mobility of the tractor, it can be placed within easy loading distance, with the result that it is now practicable to clean a sludge bed in much less time than was formerly required. The bins dump the load freely. The accompanying illustration shows the sludge being piled into windrows on either side of the tractor. When the disposal area is filled, the tractor is run on top of the sludge and windrows are started at a higher level.

In the design of the mechanism the Sanitary District required that the bins be easily removable so that the stripped tractor might be available for other purposes around the plant. Shortly after the unit was purchased, construction of an earth levee required the use of a tractor in an important part. Three laborers in 30 min. removed the bins, and only slightly more time was required to replace them after the levee was completed.

Dried sewage sludge being piled in windrows by side-dump bins on crawler tractor.

Design Simplification for Eccentric Rivet Connections

Moment of inertia and section modulus of rivet groups expressed in terms of pitch and number of rivets—A graphic method of determining the rivet of maximum stress

By Abraham Frank
Roselle, N. J.

IN THE investigation of eccentric rivet connections one of the chief items of computation is the so-called moment of inertia of the rivet group. For a line of rivets such as that shown in Fig. 1*a*, the moment of inertia about the X-axis through the center of gravity is $I_x = \Sigma d^2$; while for a group such as that shown in Fig. 1*b* the polar moment of inertia about the c.g. is $I_p = \Sigma d^2 = \Sigma x^2 + \Sigma y^2$. Texts with which the writer is familiar seem content to accept these equations as they stand for the final form, despite the fact that for the usual case of a uniform spacing of the rivets a simple formula can readily be developed to give I directly in terms of the pitch and the number of rivets.

In Fig. 1*a* let p = the pitch and N = the number of rivets. Center about each rivet a square of side p, so that the whole inclosing rectangle is of width p and depth Np. Inasmuch as the I of each square about the X-axis is equal to its I about a parallel axis through its own c.g., plus the area times the square of the distance between the axes, it is possible to write for the moment of inertia of the inclosing rectangle

$$I_{xx} = \frac{p(Np)^3}{12} = \Sigma\left(\frac{p^4}{12} + p^2d^2\right) = \frac{Np^4}{12} + p^2\Sigma d^2;$$

and solving for Σd^2, as the moment of inertia of the rivet group,

$$I_x = \Sigma d^2 = \frac{p^2(N-1)(N)(N+1)}{12} \quad (1)$$

The section modulus of this line of rivets is

$$S_x = \frac{I_x 2}{(N\text{-}1)\,p} = \frac{p\,N(N+1)}{6} \quad (2)$$

For any number of parallel and similar rows of rivets, I_x or S_x is simply that number times I_x or S_x for one row. Thus for the commonly occurring connection of N rivets in two rows,

$$S_x = \frac{p\,N(N+2)}{12} \quad (3)$$

The moment of inertia of a line of N rivets about the end rivet (the assumption with regard to a seat-and-stiffener bracket) can be derived directly from Eq. (1) and is, accordingly, as follows:

$$I_x = \frac{p^2(N-1)(N)(2N-1)}{6} \quad (4)$$

To find the polar moment of inertia of a group such as that shown in Fig. 1*b*, it is necessary only to note that $I_p = \Sigma x^2 + \Sigma y^2$ exemplifies the general principle that $I_p = I_x + I_y$. Thus the computations for Fig. 1*b* are simply

I_x (3 rows of 7) $= \dfrac{(3)(9)^2(6)(7)(8)}{(12)(4)^2} = 425\frac{1}{4}$

I_x (2 rows of 6) $= \dfrac{(2)(9)^2(5)(6)(7)}{(12)(4)^2} = 177\frac{3}{16}$

I_y (7 rows of 3) $= \dfrac{(7)(4)^2(2)(3)(4)}{(12)} = 224$

I_y (6 rows of 2) $= \dfrac{(6)(4)^2(1)(2)(3)}{(12)} = 48$

$I_p = 874\frac{7}{16}$

When a group of N rivets such as that shown in Fig. 1*b* is subjected to a load P and a bending moment M, all rivets take the same direct shear $V = P/N$, and each the different torsional shear $T = Md/I$. The resultant shear R must be found from V and T according to the usual parallelogram of force. The rivet most remote from the c.g. always takes the greatest value of T, but not necessarily the greatest value of R; for a rivet nearer to the c.g., and taking a smaller value of T, may yet be so much nearer to the X-axis as to give a more acute parallelogram, with a longer diagonal. Thus we read in texts that "one of the outside rivets will receive the greatest resultant of direct stress and moment stress," leaving it to be implied that R must be computed for several outside rivets to find the one taking the maximum stress. The writer sought for a criterion which would locate directly the rivet of maximum stress, and proceeded as follows:

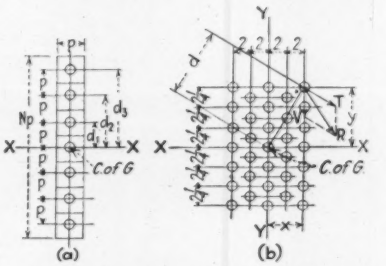


FIG. 1—THE moment of inertia of such rivet groups as these may be expressed in terms of pitch f and number of rivets N.

Fig. 2 is a general case in which P is oblique with the X- and Y-axes. Since the location of P with respect to the c.g. is part of the given data, P may be resolved where it crosses the X-axis, into known components P_x and P_y. The distance e and the bending moment $M = P_y e$ may then be determined. Since all rivets take the same direct shears $V_x = \dfrac{P_x}{N}$ and $V_y = \dfrac{P_y}{N}$, and each the different torsional shear $T = \dfrac{Md}{I}$, the resultant shear on any rivet is

$$R = \sqrt{\left(V_x + \frac{Mx}{I}\right)^2 + \left(V_x + \frac{My}{I}\right)^2} \quad (5)$$

Since any other rivet may take less or more stress than the given rivet, there may be some with the same stress; for these rivets, R is constant, and in Eq. (5) x and y remain as the only variables, permitting location of a curve, upon which all rivets have the same total shear. By making Eq. (5) read

$$\frac{IR}{M} = \sqrt{\left(\frac{V_x I}{M} + x\right)^2 + \left(\frac{V_x I}{M} + y\right)^2} \quad (6)$$

it is immediately recognized as the equation of a simple circle, whose center O is at $\left(-\dfrac{V_y I}{M}\right)\left(-\dfrac{V_x I}{M}\right)$, and whose radius is $\dfrac{IR}{M}$.

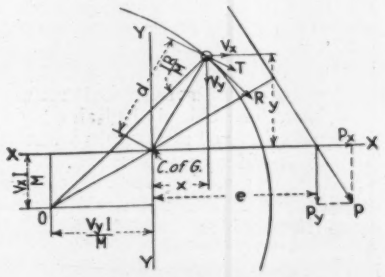


FIG. 2—GRAPHICAL METHOD for locating the rivet of maximum stress in a group.

Thus the criterion becomes apparent: upon a sketch of the rivet group locate the center O, and then find the rivet most remote from it rather than from the c.g.; this will be the rivet of maximum stress. Obviously the sketch need be only a bare skeleton of the group. Since O always lies on the perpendicular to P, extended through the c.g., it is not necessary to bother with signs in finding the coordinates of O. But hav-

ing located the rivet of maximum stress, the proper signs of its coordinates must be used in Eq. (5). Furthermore if either V_x, V_y or M is opposite in direction to that assumed for it in Fig. 2, it must be made minus in Eq. (5).

The criterion proves that when the perimeter of the rivet group is rectangular, one of the corner rivets is the rivet of maximum stress.

Street Paving in Philadelphia on Two NRM Projects

Pre-proportioned and preheated aggregates from central plant used in regular paving mixers with flame heating attachments

PHILADELPHIA city paving, which has in the past ceased almost invariably on Nov. 15, has this winter been varied by the active prosecution of two street-pavement operations. The contracts for both projects, although both are within the Philadelphia municipal limits, were let by the Pennsylvania state highway department. The construction work is also under the direction of this authority. Only the surveys were made by Philadelphia. Being NRM projects, the cost of construction is borne entirely by the federal government.

One of the jobs is located on Chestnut St., between 30th St. and Woodland Ave. The other is on Baltimore Ave., between 29th and 52nd Sts. Both streets are on the city's connecting link for U. S. Route 1, which is the principal north-and-south route on the Atlantic seacoast. Traffic, both motor and street-car, continues to be routed through both jobs during construction since detours would be impracticable.

Traffic counts taken on the Chestnut St. project shortly after commencing construction operations revealed a daily average of 47,000 vehicles. Baltimore Ave. carries somewhat less traffic, although it, too, is a heavily traveled street.

The Eastern Asphalt Paving Co., Philadelphia, has the contract for the Chestnut St. work at a contract price of $33,000. Here an old pavement is being replaced with a concrete base and a sheet-asphalt top. The pavement is 1,609 ft. long and 44 ft. wide, and includes a double car-track zone, 18 ft. 8 in. wide. The pavement base in the car-track zone is 9½ in. and 11½ in. thick. The two thicknesses are made necessary because of two different rail-heights (7 and 9 in., respectively). The concrete base extends only to the bottom of the ties. The base for the remainder of the paving is uniformly 9 in. thick. The asphalt surface is 2½ in. thick (1-in. binder and 1½-in. surface).

The mix for the base is 1:1.8:3 and the water content is 5 gal. per sack of cement; the cement content therefore averages 1½ bbl. per cu. yd. The coarse aggregate is gravel, 40 per cent crushed, and both fine and coarse aggregates are dredged from the Delaware River, a few miles above Philadelphia.

Four test beams are made up from each day's pour, to determine the strength of the concrete and the opening time. Two beams are made in the morning and two in the afternoon. They are protected and cured with the pavement until just before breaking at the testing laboratory maintained on the job by the state highway department. The following 48-hour beam breaks (modulus of rupture) are typical of the flexural strengths of the concrete obtained at that age:

Test 1	*Test 2*	*Test 3*	*Test 4*
540 lb.	560 lb.	540 lb.	555 lb.

The average is 548.7 lb.; the average atmospheric temperature during the placing and curing of specimens was 45 deg.

The state specifications permit of laying asphalt when the concrete base develops a beam strength of 500 lb. It will be noted that this requirement was met well within 48 hours. The specifications also require that the concrete must have a temperature of at least 60 deg. when deposited, and that its temperature must not drop below 50 deg. pending development of the 500-lb. beam strength. Using high-early-strength cement, heated aggregates, a flame thrower in the mixer, and prompt protection of the deposited concrete with burlap and straw, the contractor has experienced no difficulty in meeting these requirements.

The contractor is mixing his concrete on the job, using pre-batched as well as pre-heated aggregates. The work got under way Nov. 27.

As stated, this is an NRM project, which limits the working hours per man per week to 30. To meet this requirement, the contractor has established a standard day of ten hours and maintains two crews alternately working three days a week. The job has provided employment for about 100 men on the above basis.

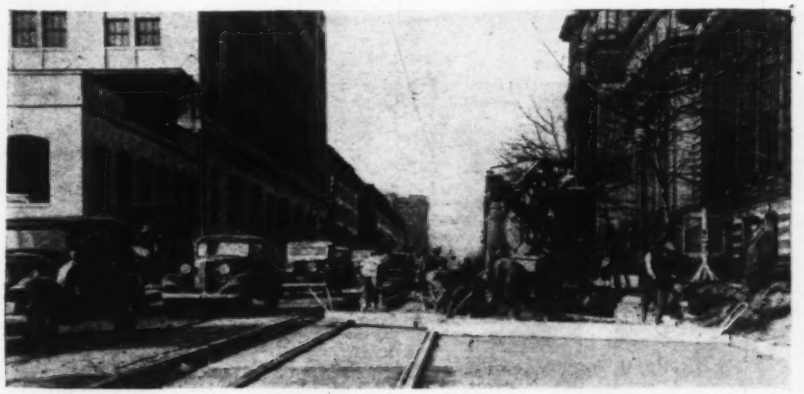
The paving on Baltimore Ave. is confined largely to the double-car-track zone. The specifications are practically identical with those of the Chestnut St. project. The Union Paving Co., Philadelphia, is the contractor, and the bid price was $20,000.

This contract calls for 1,755 lin.-ft. of concrete base and asphalt top to a width of 18 ft. 8½ in., and also for the same length, two additional 4-ft. widths of asphalt for replacing worn-out surfacing on each side of the car-track zone. No additional base is required for these areas.

Using high-early-strength cement as on the Chestnut St. job, also similar construction methods, the same concrete strengths are obtained; the asphalt surface is laid on the base after the same brief interval following pouring. Also, as on Chestnut St., the contractor is mixing his own concrete, using a paver. He is also making use of pre-batched and pre-heated aggregates, although from a different source.

This project is furnishing employment to about 70 men, working 30 hours a week. Here, too, the standard day is ten hours, and the men are divided into two crews alternately working three days a week. In addition to the contractor's forces on the two jobs, the street-car company has had from 20 to 40 men at work almost continuously on the tracks, preparatory to concreting.

PAVING CHESTNUT ST., Philadelphia, using aggregates preheated at a central plant and a flame injector on the mixer.



Gas-Main Tunnel Driven Under Schuylkill River

Necessity of keeping pipe line 15 ft. below channel bottom determined resort to deep tunnel—Tunnel flooded after completion—Special anchorages for tunnel mains and shaft risers

By Charles C. Jones
Assistant Superintendent, Philadelphia Gas Works Co., Philadelphia, Pa.

THE underwater crossing of streams with gas mains has always been a serious problem with the gas engineer. When the stream is not too wide and fairly shallow, the general practice has been to construct a manifold of several small lines whose total capacity is equal to that of the main line, lay these upon the bottom of the stream and allow them to settle at will into the mud. An improvement upon this method is to dig a trench in the river bottom and bury the pipes. When the river is fairly wide and has a navigable channel, a more elaborate and costly method must be used.

In 1922 a 20-in. pipe was placed across the Schuylkill River by dredging a cross channel, driving piles, placing caps upon these piles and then fastening the pipe to the pile bents. When completed, the top of the pipe line had to be about 15 ft. below the bottom of the established river channel. Our 1933 construction program included a 30-in. connection across the Schuylkill at the same point, and after considerable study of costs, advantages and disadvantages, an underriver tunnel to contain this 30-in. pipe and a spare 30-in. line was decided upon. The line of the tunnel was chosen slightly diagonal to that of the Passyunk Ave. bridge, keeping a safe distance away from the piers and abutments. The east shaft was located just within the property line of the Station A plant, while the west shaft was on the bank of the river within the dedicated area of Passyunk Ave. The United Engineers & Constructors, Inc., designed the structure and furnished one of its engineers to supervise the construction.

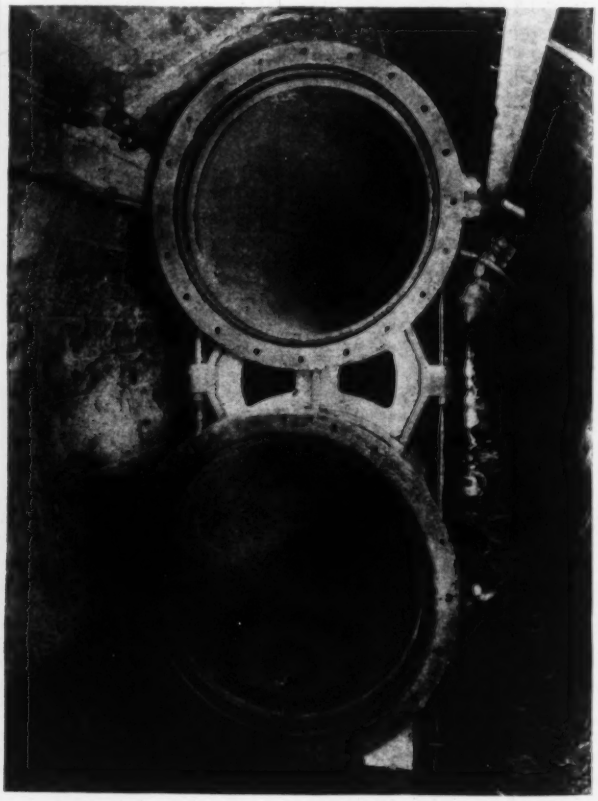
Test borings were made every 60 ft. along the proposed line, and it was found necessary to locate the tunnel 148 ft. below mean high water to find hard unfaulted rock. This made the east shaft about 142 ft. and the west shaft 107 ft. deep, with the tunnel itself slightly more than 600 ft. long.

The shape of the tunnel was quite important, as the removal of rock at that depth is costly. Space was needed for two 30-inch pipes, with sufficient room for installation and future inspection. The cross-section finally decided on was slightly egg-shaped, with the greatest inside width 7½ ft., and the height 7 ft. 10 in. The two gas lines were placed one over the other, with their centers 6 in. off the center line of the tunnel. This gave ample walking space along one side. The shafts were circular, with an inside diameter of 7½ ft. The ceiling of the tunnel where it met the side walls of the shafts was sloped upward at an angle of 45 deg. to permit the use of pipe in 16-ft. lengths.

As a safety and economy measure the tunnel was to be flooded with water after all work was completed. From a safety standpoint the head of water against the outside surface of the pipe would prevent the escape of any gas and the formation of an explosive mixture in the tunnel. A leak would be indicated by an increased volume of liquid in the drips at the bottom of the pipe risers.

BRINGING SECTION OF GAS PIPE from shaft into tunnel, to be carried forward by trolley chain hoists.

TWO 30-IN. GAS MAINS set one above the other in saddles and anchored against flotation in flooded tunnel.



The economy is obvious, as continuous pumping to keep the tunnel free of water would not be necessary.

As we wanted a gas-tight line, subject to the least amount of corrosion, a complete cast-iron line with mechanical joints was specified, and pipe in 16-ft. lengths with double-simplex joints was installed. The special castings were also cast iron with simplex joints.

The bottom pipe line was supported on reinforced-concrete saddles, cast on the floor of the tunnel. Heavy anchor bolts were cast into the floor on each side of the saddles. Cast-iron saddles rested on the lower pipe line and supported the upper. When the pipe anchorages were assembled, the upper line was strapped to the cast-iron saddles with ¾-in. U-bolts and the saddles fastened to the anchor bolts with 1-in. rods. In this way the two lines of pipe were rigidly attached to each other and to the tunnel floor, with no possibility of floating when the tunnel was flooded.

The tunnel and piping were graded from west to east, with a fall of ½ in. in 16 ft. Drips were installed only at the bottom of the east risers. Every two lengths of pipe in the risers had to have an independent means of support, to avoid crushing the lower sections. The supports were a 4-in. steel collar placed around every other length, just behind the bell and resting on a steel framework concreted into chases left in the walls of the shafts. To make sure of this support, a minimum clearance of ¼ in. was left between the spigot end and the back of the bell in every second joint. Two 9-in. anchor beams were placed across the top plugs of the risers and anchored to the shaft walls.

Construction

The shafts were sunk by casting a section of the lining in the proper location on the surface of the ground and then excavating the earth from the inside of this ring of concrete. As the excavating progressed, the wall section sunk and a new section was cast upon the preceding one. This procedure was repeated until rock was reached at a depth of 95 ft. Because of water conditions, air-locking had to be used to seal the concrete walls to the rock before blasting could be started. This was the only time air was used.

When driving the tunnel through the rock, the Francois system of cementation was used. This consisted of drilling 2-in. holes, slightly flared, completely around the circumference of the tunnel. These holes penetrated the rock about 60 ft. ahead of the working face and gave advanced information of water and bed rock faults that were to be encountered. Cement grout was forced into these holes under pressure, tending to seal up the water-bearing faults and strengthen the rock structure adjacent to the workings.

To facilitate the pipe installation, two rows of brackets 2 ft. either side of the pipe on 8-ft. centers were cast in the ceiling of the tunnel. From these brackets two lines of I-beams were hung, forming the overhead tracks for a carriage upon which the lengths of pipe were transported from the shaft to their final position. All of the pipe and fittings except the west risers were lowered and installed through the east shaft. The pipe was lowered by means of a steel collar placed behind the bell with chains between this collar and the hook of the crane. When the pipe reached the bottom of the shaft it was snaked around the bend, lowered onto the carriage and pulled along the tunnel to its proper position.

On top of the east shaft is a brick pump-house containing two deep-well pumps, one for pumping the pipe drips and one connected to the tunnel sump. There is also a hand-operated winch for raising or lowering a small steel elevator. The west shaft is covered with a cement slab containing a manhole opening. On this side there is a ladder leading down from the entrance chamber to the tunnel.

The entire pipe installation was tested at 25 lb. per sq.in. air pressure and found tight. All joints were tested individually with soapsuds, and the outside of all pipe, bells and fittings were painted with soapsuds to detect porous iron.

The tunnel is now filled with water, and one of the 30-in. mains is purged and in use. The contractors were the Dravo Construction Co., Pittsburgh, Pa.

Weathering Tests on Metals and Coatings Reported by A.S.T.M.

REPORTS on weathering tests which add to the general fund of information on atmospheric corrosion of metals, qualified by statements as to the caution to be exercised in interpreting any data on this type of test observation because of the vagaries of the subject, were presented in a symposium at a general session of the regional meeting of the American Society for Testing Materials in Washington, D. C., March 7. No attempt was made to coordinate the data presented, the purpose of the program being to bring out unofficial progress reports that would be of immediate aid to materials engineers prior to subsequent studied conclusions and final committee action.

Moisture and smoke as factors

A paper on "The Influence of Rainfall and Smoke on the Corrosion of Iron and Steel," by G. N. Schramm and E. S. Taylerson (American Sheet & Tin Plate Co.), pointed out the lack of direct relationship between the amount of rainfall and the corrosion of commercial steel and iron during a one-year weathering period. The figure of total rainfall apparently is of small value as a factor in corrosion because of the effect of other influences. Snowfall, for example, is reported as precipitation, but often is blown away without producing moisture on the metal. Also, the ordinary precipitation records do not account for condensation, melting snow or fog, and do not indicate the length of time that the test specimen remains either wet or dry. There is also the further indirect effect of rain in washing away water-soluble salts. In general, rainfall data were considered of little value as a measure of corrosive effect, although a detailed study of complete weather records is a factor to be considered.

In two cases of test specimens exposed to a typical industrial atmosphere it was found that corrosion was roughly proportional to the amount of fuel consumed in the adjacent industries. However, in another case such a result was not indicated, and, in general, any attempt to generalize might produce improper conclusions. Also, the factor of air pollution is definitely tied in with the influence of moisture because of the combination that results in the formation of acid compounds promoting corrosion.

One of the unusual observations of the test series was the fact that in a one-year cycle the specimens whose exposure began in the fall of the year showed a much greater average loss of weight than those whose exposure started in the summer months. No direct conclusion was drawn from this observation except to point out the important effect of seasonal change on weathering tests, particularly those of a single year's duration. "The complex nature of these factors, alone and combined, may account for the lack of agreement observed in the results of tests made during different periods of exposure."

Galvanizing as protection

Information on the atmospheric resistance of galvanized and uncoated sheeting both in test specimens and in actual service was presented in a paper by R. F. Passano (American Rolling Mill Co.). Some of the observations and conclusions reached were:

1. Zinc coatings last longer than cadmium coatings of the same weight, where observations were made.

2. The amount of zinc coating required for a given protection varies widely with the locality.

3. Zinc coating is relatively ineffective when sheets are stored in piles and moisture accumulates.

4. Uncoated steel sheets perforate from the under side on test-rack specimens, and any increase in thickness apparently increases the life of the sheet by an amount greater than the increase in thickness would indicate.

5. Effect of locality on zinc and steel corrosion differs widely.

Possibilities of damage

On the question of actual service of galvanized roofing sheets, the author stated that the possibility of damage to coating in the storage pile prior to installation is an important consideration. A further factor is the serious local damage that may result from the accumulation of débris and dampness on the under side of roofing sheets at the purlin supports. The lap in ordinary corrugated roof construction was considered the weakest point and resulted in a conclusion that "The life of a corrugated roof is the life of the base metal at the laps."

Results of outdoor tests on ferrous specimens conducted by committee A-5 were reported by C. D. Hocker (Bell Telephone Laboratories) for the purpose of offering interpretations of data which the committee had previously released without comment. A copper content up to 0.15 per cent in steel sheets indicates a substantial and directly related increase in resistance to atmospheric corrosion, but a further increase in the copper content does not indicate a corresponding improvement. The most rapid rusting occurs in an industrial atmosphere, with rural atmosphere next and seacoast exposure least. Tests on copper-bearing steel sheets in sea water, failed to show that the copper content was an advantage.

An interpretation of tests made on the resistance of zinc-coated sheets to weathering indicated the greatest number of failures in industrial atmospheres, with seacoast exposure next (about one-third as many) and a rural exposure least (about 1/100 as many as the industrial). Curves showing the relation between the weight of the galvanizing and the life of the specimen, up to the appearance of first rust, indicated an almost straight-line relation on the basis of increased weight of zinc and increased life.

A paper by W. H. Finkeldey, metallurgist, Singmaster & Breyer, New York City, suggested that while it may be safer it is not possible to withhold conclusions regarding corrosion tests until all specimens have completely failed.

An outline of the tests now under way on the corrosion behavior of two dissimilar metals when coupled together was given in a paper by C. L. Hippensteel (Bell Telephone Laboratories). The tests are being conducted in a variety of atmospheres, using a specimen that consists of two 1¼-in.-diameter washers of the two metals held in close contact by a bolt, and brass washers that are completely insulated from the test pair by bakelite washers and tubing. Although the test has not continued long enough to indicate final results, it was noted that the activity at Phoenix, Ariz., a rural location, was negligible. The corrosion effect was more marked in marine and industrial atmospheres, indicating a variety of results depending upon the combinations of metals coupled together. A period of longer exposure is essential to provide confirmatory data.

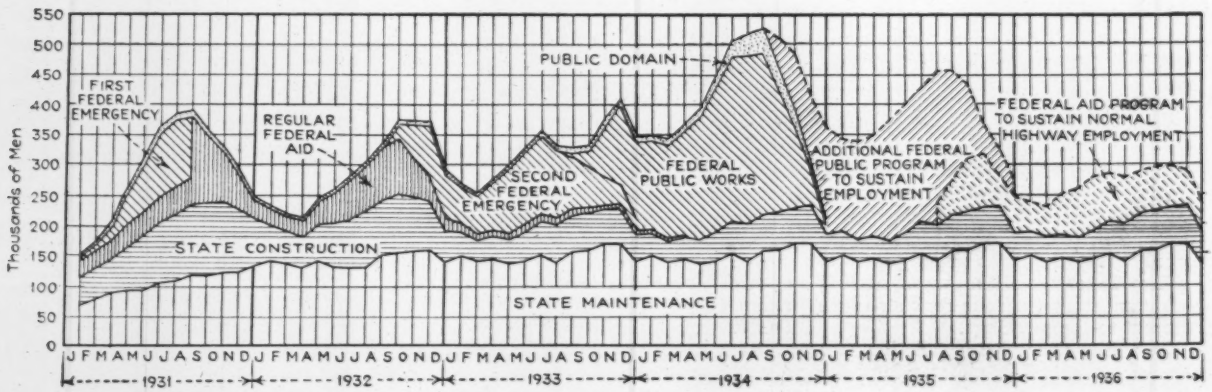
Employment on Highways

For four depression years the volume, rate and spread of employment on highways have featured the efforts of national and state governments to reduce unemployment by construction

A REVIEW of highway employment figures during the years of expenditure of funds from the Recovery Act and the federal emergency apropriations of 1931 and 1932 indicates positively: (1) a remarkably large volume of employment maintained; and (2) a precipitous decrease in employment at the end of 1934 unless further financing is provided. The facts depicted are represented graphically by Fig. 1. This chart throws light on a broad range of questions connected with employment on highways.

The main questions round up into these broad classifications considering both normal road activity and activity induced by the emergency federal appropriations of the present year and of the preceding three years: (1) volume of employment, (2) rate of putting men to work, (3) distribution of employment, and (4) decline and future prospects of employment. Finally comes consideration of a future highway financing policy. All figures presented are exclusive of roads not normally under federal and state administration but do include secondary and municipal highway operations provided for in the Recovery Act and normally not under federal and state administration.

FIG. 1—DIRECT employment in man-months on road improvement for four years ending in 1934, and suggested financing for 1935.


Thousands of Men
550
500
450
400
350
300
250
200
150
100
50
0
FIRST FEDERAL EMERGENCY
REGULAR FEDERAL AID
SECOND FEDERAL EMERGENCY
PUBLIC DOMAIN
FEDERAL PUBLIC WORKS
ADDITIONAL FEDERAL PUBLIC PROGRAM TO SUSTAIN EMPLOYMENT
FEDERAL AID PROGRAM TO SUSTAIN NORMAL HIGHWAY EMPLOYMENT
STATE CONSTRUCTION
STATE MAINTENANCE
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1931
1932
1933
1934
1935
1936

Volume of employment

Federal and state highway employment directly on the job is shown in man-months by the graph in Fig. 1.

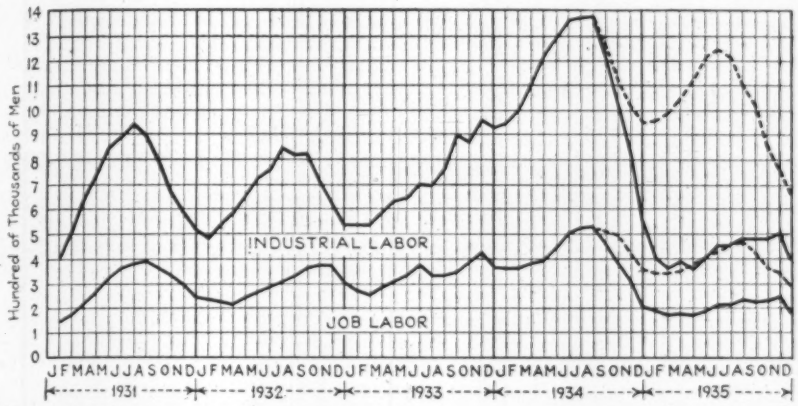

Hundred of Thousands of Men
INDUSTRIAL LABOR
JOB LABOR
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1931
1932
1933
1934
1935

FIG. 2—COMBINED EMPLOYMENT provided by job and industrial work created during four years by federal and state road construction and maintenance.

Table I shows the January employment in man-days for each of the four years covered by emergency highway construction. In both table and chart the figures represent continuous jobs afforded and not the number of individuals appearing on the payrolls. Analysis of the records by the Bureau of Public Roads shows a ratio of 1.8 individuals appearing on the payrolls to each one reported continuously employed. Thus the total of 179,499 men continuously employed on federal and state work for January, 1934, indicates that direct employment was provided for longer or shorter periods for 323,235 individuals.

The figures given by the chart and table do not include administration or supervisory labor or labor indirectly created in the industries serving roadbuilding. Under present code and Recovery Act restrictions on working hours and other labor conditions the ratio between direct labor and indirect industrial labor is calculated as 1:1½ by the Bureau of Public Roads. Thus for January, 1934, the following figures are arrived at:

Job labor, man-days	315,989
Industrial labor, man-days	473,983
Administration and supervisory	52,000
Total man-days	841,972

The general ratio between job labor and industrial labor for the four years under consideration is shown by Fig. 2. Briefly, appraisal of job labor alone as representing men at work is seriously underestimating the volume of employment furnished by roadbuilding in the four years of emergency operations. The great proportion of this labor provided by Recovery Act and emergency federal loans is emphatically clear.

Rate of employment

Employment generally has been provided with speed. As shown by Fig. 1, the $80,000,000 loan of 1931, required by law to be spent by Sept. 1, was so spent in seven months. The second loan of $120,000,000, made in 1932, to be spent by the end of 1933, was spent in sixteen months. In the same three years all regular federal aid was consumed. The $400,000,000 of Recovery Act grant, planned to cover a period of eighteen months, will all be consumed by Jan. 1, 1935. Including regular federal aid, which cannot be dissociated from the $200,000,000 federal loan, a total of about $800,000,000 of federal money has been turned into wages in 48 months.

Turning to the Recovery Act program, Tables II and III are indicative of the rates at which the funds have been committed and direct employment has progressed. These figures call for explanation only in respect to the lag in getting employment started. With the Recovery Act approved on June 16, construction and employment started in August. This lag was due in larger part to procedures set up by the Public Works Administration and to a lesser measure to the classification and spread of projects required by law.

A major cause of delay was the PWA requirement that a full project and expenditure program was to be submitted by each state for general approval previous to the beginning of work. This requirement and various other stipulations that handicapped the start of work were afterwards partly dropped, but previously they had delayed the start about five weeks. As shown by Table II, contracts began to be awarded in numbers in August, and thereafter the projects under contract accumulated at the rate of about 1,000 a month. For the seven

TABLE I—JANUARY EMPLOYMENT IN MAN-DAYS OF DIRECT LABOR ON HIGHWAYS FOR FOUR YEARS 1931-1934

	1931	1932	1933	1934
Total federal	19,482	29,518	15,489	154,154
Total state	32,772	58,590	39,906	25,345
State and federal	52,254	88,108	115,404	179,499
State maintenance	54,299	141,081	151,039	136,490
Construction and maintenance	106,553	229,189	266,443	315,989

TABLE II—CUMULATIVE PROGRESS IN COMMITMENT OF RECOVERY ACT FUNDS FOR HIGHWAY CONSTRUCTION IN NUMBER OF PROJECTS AND AMOUNTS OF MONEY.

Date	Advertised	Awarded	Under Construction*	Completed
Aug. 31, 1933	(964)	(279)	(81)	.....
	$66,275,203	.....	.....	.....
Sept. 30	(2,033)	(1,165)	(617)	.....
	.....	.....	.....	.....
Oct. 30	(3,230)	(2,244)	(1,597)	.....
	.....	.....	.....	.....
Dec.	(4,509)	(3,464)	(2,441)	(203)
	$222,770,000	$195,032,000	$134,470,000	$49,660,000
Dec. 30	(5,287)	(4,494)	(2,752)	(476)
	$273,849,000	$232,490,000	$159,575,000	$11,772,000
Feb. 3	(5,835)	(5,123)	(3,345)	(631)
	$301,188,000	$266,221,000	$196,875,000	$16,593,000
Mar. 3	(6,351)	(5,595)	(3,686)	(715)
	$321,638,000	$288,092,000	$216,291,000	$18,653,000

*About 20 to 25 per cent of work under construction at any date is completed and paid for by progress payments and this adds to "completed" figures in money paid out.

TABLE III—DIRECT EMPLOYMENT IN MAN-DAYS BY MONTHS IN FEDERAL CONSTRUCTION AND IN ALL CONSTRUCTION AND MAINTENANCE

	Total Federal Constr.	Total Constr. and Maint.
September, 1932	122,193	374,405
November, 1932	129,933	371,667
January, 1933	75,498	266,443
February, 1933	78,215	255,256
March, 1933	95,704	279,213
April, 1933	122,256	299,000
May, 1933	139,831	330,138
June, 1933	152,276	359,605
July, 1933	129,205	332,227
August, 1933	111,211	329,813
September, 1933	115,047	337,973
October, 1933	154,016	384,029
November, 1933	185,860	420,069
December, 1933	174,358	362,031
January, 1934	154,154	315,989

TABLE IV—SUMMARY BY TYPES OF WORK TO FEB. 1, 1934, OF COSTS AND MILEAGES OF ROAD CONSTRUCTION WITH RECOVERY ACT FUNDS

	Estimated Total Cost	Miles
Graded and drained	$34,127,495	4,424.6
Sand clay		
Untreated	2,737,534	532.2
Treated	4,810,119	594.6
Gravel		
Untreated	33,873,131	5,128.9
Treated	11,420,172	1,209.4
Macadam		
Untreated	2,288,716	206.4
Treated	5,648,785	383.0
Low-cost bituminous mix	17,343,205	1,909.4
Bituminous macadam	12,373,938	613.7
Bituminous concrete	26,143,267	811.2
Portland cement concrete	99,272,176	2,706.0
Block	4,821,918	66.3
Bridges and approaches	37,384,843	71.8
		(2,746)
Grade separations, railroad-highway	7,814,524	14.3
		(194)
Grade separations between highways	793,990	0.6
		(12)
Miscellaneous	333,842	.....
Total	301,187,653	18,672.4

months to March 3 the contract commitment of money has averaged about $38,000,000 a month.

Table III, showing employment, begins about with the first expenditures of the second emergency loan in 1932 and carries through January, 1934. Fig. 1 presents the same figures graphically, and Fig. 2 shows the combined direct and industrial employment.

The volume of employment indicated by the preceding data has been widely distributed, particularly in the case of the Recovery Act expenditures. As shown by Table II, 6,351 separate projects had been advertised for contract on March 3, or about $322,000,000 of work. The average is about twenty projects per million dollars. The spread of employment according to kinds of work is indicated by Table IV, as of Jan. 31, 1934. A striking variety of work is indicated, and the mileage is great enough for six two-lane roads from ocean to ocean. The total number of projects is 5,835. In these projects are included all the recognized types of highway construction.

As shown by Fig. 1, all federal funds now provided for roads will have been spent by Jan. 1, 1935. In the last three months of this year federal road expenditures, with all that they mean in direct and indirect employment, will have ceased. By dotted zones Fig. 1 indicates a suggested extension of the federal highway program which will hold employment without a precipitous drop during the latter months of 1934 and the year 1935. It contemplates a federal grant of about the amount granted by the Recovery Act of 1933 and the restoration (beginning July 1, 1934) of the $125,000,000 of annual federal aid prevailing before the depression and in 1930 and 1931.

Federal appropriations for four years have afforded a great volume of employment. This employment has been provided with remarkable speed and has been widely distributed both geographically and in classes and varieties of road work performed. Unless further federal financing is provided, roadbuilding and employment will decline to comparatively small amounts with the completion of this year's work.

Economics and Research at Railway Convention

A.R.E.A. adopts new standard sections and a standard rail joint and proposes new steel-bridge specifications—Reports on analytical studies of practical problems

IMPORTANT theoretical and analytical studies, research activities and a very practical cooperation with government authorities in relation to the use of standards in making purchases were prominent features in the work of the American Railway Engineering Association and its committees during the past year, as evidenced by the reports presented at the annual meeting held in Chicago, March 13-14. The studies included such matters as determining profiles of humps for gravity switching, relation of volume of traffic to operating expenses, economic values of different sizes of rails, and economic lengths for freight trains. They were supplemented by numerous other reports on standards, designs, specifications and methods of practice. Numerous changes and additions to the "Manual of Recommended Practice" were adopted, owing to continual developments since the latest edition in 1929.

Of particular importance has been the action of the committee on standards in making prompt contact with the Federal Coordinator of Transportation and his director of purchases, who recognized the value of the "recommended practices" of the A.R.E.A. Thus the first step of the director of purchases was to ascertain those standardized matters which involved the greatest expenditures, the most conspicuous of which were the rail sections. At a meeting held in October by the president and directors of the A.R.E.A. and the members of the committee on standards, Mr. Lockwood, director of the section of purchases on the staff of the Federal Coordinator, explained his policy of approving adopted standards rather than creating new ones, and of relying upon the expert knowledge and experience represented in the A.R.E.A., special reference being made to standards for rails, splice bars, track material and lumber.

Convention proceedings

In a two-day, five-session meeting, the association considered and disposed of the reports of 28 of its 30 committees, although these reports filled six bulletins aggregating about 1,000 pages. The only reports missing were those of two committees appointed last year, on the comparative economics of bridges and trestles and on track as a unit structure. A review of the history, development, purposes and work of the association was featured in the address of the president, W. P. Wiltsee (chief engineer, Norfolk & Western).

Research and standardizing activities were reviewed by the secretary whose report showed a membership of 2,028—a net loss of 327 (21 by death) for the year—but the funds stand at $75,392 as compared with $71,427 in 1933. Two honorary members were elected: George W. Kittredge the second president (1900), and Prof. A. N. Talbot. The registered attendance was 510 members and 198 visitors, as compared with 388 and 217 in 1933. Officers elected for 1934 include: president, John E. Armstrong, assistant chief engineer, Canadian Pacific Railway; first vice-president, Robert H. Ford, assistant chief engineer, Rock Island Lines; second vice-president, A. R. Wilson, engineer of bridges and buildings, Pennsylvania Railroad; secretary E. H. Fritch (re-elected), Chicago. An ornamental bronze tablet mounted on polished wood was presented to the retiring president, Mr. Wiltsee.

Of exceptional importance, pointing the way to possibilities of great advance in railway economics and operating efficiences, was an address by A. A. Potter, dean of engineering at Purdue University, on the subject of "Research for the Railways." An abstract of his address follows this report.

New bridge specifications

Complete specifications for steel railway bridges with fixed spans up to 400 ft. and for Cooper's E-72 loading, submitted tentatively by the committee on iron and steel structures, are intended eventually to replace the specifications now in the Manual, which are for spans up to 300 ft. and with E-60 loading. The committee on wooden bridges and trestles also proposes an increase of design load to E-70, instead of the present E-45 and E-60, in order to obtain the full life of structures under increasing loads of engines and the heavy loads on modern tender axles. This report included information on shear in checked beams and on methods of strengthening timber trestles, giving new designs of metal fastenings.

That trestles of creosoted timber have a life at least twice that of untreated timber, and that structures of untreated timber are not generally considered economical, were conclusions adopted as submitted by the committee on wood preservation. Specifications for a single grade of creosote (instead of the three grades now in the Manual), and for the treatment of air-seasoned Douglas fir were also adopted. Other subjects included progress reports on termites and wharf borers and the life of treated

piling, together with experiments on poisoning the soil around poles to protect them from insect attacks. Plans for reinforced-concrete trestles of E-60 loading, composed of pile bents and precast deck slabs, submitted for the Manual by the committee on masonry, were adopted.

Bridges and buildings

Railway bridges over navigable waterways were discussed by the committee on rivers and harbors, urging that statutes should be changed to give a more reasonable distribution of cost. Its report pointed out that the present statutes are based on the theory that there is an inalienable right inherent in the use of a waterway and that all railway bridges crossing it must be provided at the sole cost of their owners. Furthermore, excessive cost is imposed upon the railways by requirements for unnecessary clearance heights. The committee's outline of economic principles relative to clearances and to distribution of cost were adopted at the suggestion of the president, though Mr. Jenkins (B. & O.) pointed out that Congress could not be governed by such principles, desirable as they may be.

In a report on the vibration of concrete the committee on masonry predicted rapid increase in the use of this method of placement and in the development of apparatus. Its proposed definitions of "foundation" as the natural material (whether or not strengthened by piling) and of "substructure" as that part supporting the structure and loads, were adopted after some discussion. Besides a review of various forms of expansion joints and a discussion of central-mixed and transit-mixed concrete, the committee submitted tentative specifications for foundations, tunnel lining and "shotcrete" concrete, this term (not copyright) being adopted to cover sand-cement mixtures placed pneumatically through pipes or hose. Revised rules for bridge inspection, fire prevention and the maintenance of masonry bridges, submitted by the committee on rules and organization, and forms for bridge inspection and water station reports, submitted by the committee on records and accounts, were adopted for the Manual.

Relative cost of coal and ore docks on the Great Lakes was estimated by the committee on rivers and harbors as 100 for timber, 167 for concrete and 187 for steel, but the maintenance costs are 100, 70 and 76 respectively. Revised specifications for membrane waterproofing to replace those now in use, were adopted on recommendation of the committee on waterproofing railway structures, which also submitted a series of principles governing the use of waterproofing and damp-proofing. Similarly, revised specifications for asphalt roofing and specifications for electric freight and baggage elevators, as submitted last year by the committee on buildings, were adopted. The relative merits of wood and fireproof materials for roof coverings were also discussed by this committee. As to dust explosions in grain elevators, conclusions were that the hazards might be reduced by: prevention of dust accumulations, dust-tight electric equipment, ventilation, and suction-fan removal of dust in suspension where grain is being agitated.

For air-rights buildings over tracks and railway property, a form for conveyance of title was submitted by the committee on uniform general contract forms. This committee also had forms of agreement on grade-separations, pipeline crossings under railways and the purchase of electrical energy in large volume (as for traction), the last two being adopted for the Manual.

New rails and rail joints

Substitution of a new 112-lb. rail for the 110-lb. section in the Manual, proposed last summer by the committee on rail, was shown by the report to have been approved promptly by letter ballot, this action being taken to expedite the manufacture of the new rail. A standard type of joint for this rail was also adopted. It is described on p. 389 of this issue.

Although rails of greater length than the 39-ft. standard are practicable (and used abroad) and promise reduced cost in track maintenance by reduction in number of joints, the rail committee considered it inadvisable to recommend any change at present, since it would require heavy plant investment by the mills. Heat treatment of rail ends in the track, to harden the metal and so prevent battering of the rails, has been found successful in extended practice, and its further use is recommended.

Annual statistics show that failures of rails rolled in 1927 were 112.4 per 100 miles of track in 1932, a decrease of 18.9 per cent below those of the 1926 rails in 1931. Transverse fissure failures numbered 7,054 in 1932, a decrease of 427 from those of 1931, this being the first decrease since 1924. The accumulated total to Dec. 31, 1932, is 65,281 transverse fissure failures. The Sperry detector car, operated under the direction of the rail committee, tested 6,600 miles during 1933, bringing its total up to 23,181 miles. It can make 20 to 27 miles daily, depending upon density of traffic and condition of the rails.

An analytical comparison of the new 131-lb. rail section ($7\frac{1}{8}$ in. high) with the 130-lb. ($6\frac{3}{4}$-in.) section which it supersedes, presented by the committee on economics of railway operation, resulted in conclusions to the effect that: (1) the increased girder strength should produce better riding track with less wear and tear and lower operating cost; (2) the improved design of head should result in better quality of metal and longer life of rail.

Details of elaborate field and laboratory tests on various forms of rail joints were discussed by Prof. A. N. Talbot, at a crowded evening session, in presenting the 300-page sixth progress report of the committee on stresses in railway track.

Yards, crossings and water service

Graphic methods for determining the series of grades for gravity or hump classification yards were presented by the committee on yards and terminals. A review of track facilities at grain elevators was accompanied by layout plans and tabulated information as to 47 plants. Length of freight trains in relation to both road and yard performance was one of the analytical studies reported by the committee on economics of railway operation, showing that in some cases the crew time required in yard-switching of a train is more than that required to run it 100 miles on the road.

Discontinuance of automatic train control of 1,738 miles of track and change from train-control to the cab-signal system on 3,155 miles was reported by the committee on signals and interlocking, which also submitted proposed indications for continuous automatic cab signals and a list of benefits due to the central traffic-control system in superseding the train order system. Crossing signals were reported on by the committee on grade crossings, with the recommendation that stop-and-go signals should be used only at special locations where their observance can be enforced by police power. This committee submitted for the Manual its specifications for crossing construction and paving with wood plank, oil-treated gravel and rails embedded in concrete, together with a discussion of the relative economy of different kinds of paving. As to vertical curves in highways at grade separations, where they are used for safe vision of drivers of motor vehicles, it was recommended that changes in the highway grades should be made with the minimum of vertical curvature that is required for safety and utility.

After a discussion of "rise and fall" the committee on economics of railway location suggested as an improved definition that: "Rise and fall is the sum of vertical ascents in rising from a starting point or level to a summit and returning to same point or level, inclusive of all grades on the profile between any two points or termini." For turntable operation the committee on shops and locomotive terminals submitted a substitute for its conclusions adopted in 1933. It now recommends electric motors (or pneumatic, where current is not available) and power wires to be either overhead or underground, but with care taken to minimize the danger of interruption by fire, storm or other emergency. The earlier conclusion specified only underground wires, but 48 of 56 railroads have expressed preference for overhead connections.

Few railway water-treatment facilities were established in 1933, owing to the general unsettled conditions, according to the committee on water service and sanitation. However, improved water conditions have led to a reduction in boiler repairs and to extensions of time by Interstate Commerce Commission inspectors for locomotives in service, owing to the excellent conditions of the boilers. Pipe joints were dealt with in a report which began with the practice of the ancient Romans and Greeks and which illustrated some 70 forms of joints. In addition to a report on disinfectants and fumigants, the committee presented a paper on the essentials of mosquito control by H. W. Van Hovenberg, sanitary engineer of the St. Louis Southwestern Ry.

Track and track materials

New material on roadbed drainage, ditching machines, treatment of slides and handling snow on tracks was adopted for the Manual, as recommended by the committee on roadway. Snow-melting devices as aids in train operation and reducing maintenance costs were discussed also by the committee on maintenance-of-way work equipment. Other subjects covered by the committee on roadway included: (1) jacking pipe through fills (with recommendation that this subject be discontinued); (2) bearing power and physical properties of soils as related to railway roadbed; (3) protecting railways against drifting sand. This last was a long report, including much information from foreign railways and ending with a series of conclusions which were adopted for the Manual.

Instead of specific depths of ballast, as now given in the Manual, the committee on ballast recommended a general statement as to depth being influenced by rail section, tie spacing and other factors, but after some discussion and criticism this was referred back to the committee. It is concluded that comparisons of cost of maintenance on different kinds of ballast can be made only on test sections of track that are under observation for a term of years. Information was submitted on laboratory tests relating to proposed specifications for stone and prepared gravel ballast.

By request of the Railway Tie Association the committee on ties has studied the problem of uniform spacing for spike holes, so that ties can be adzed and bored before treatment and then held in stock. At present, the entire lack of uniformity prevents the boring of the ties until there is a definite order and the spacing is specified. As this problem is related to rail-joint and tie-plate design, its future assignment to some other committee was suggested. Changes making the tie specifications more rigid were adopted. Besides the usual list of experimental steel and concrete ties, the committee presented an important study of mathematical methods for predicting the number of annual tie renewals over a period of years. Service records of treated ties were submitted by the committee on wood preservation, which also reported that such ties are not likely to be damaged by weed-burners if the machines are operated carefully.

Tie-plates came in for considerable attention. The committee on ties considered that longer life of ties is probable with tie-plates fastened independently of the rail fastenings. New designs for tie-plates were submitted by the committee on track for immediate adoption for the Manual, this rapid action being urged in order to have standard tie-plates to fit the new standard rail sections. Both flat-bottom and ribbed-bottom plates were included. But after brisk discussion the matter was referred back to the committee. Revised specifications and drawings for spikes and track tools were submitted by this committee. An inquiry as to the proper tightness of track bolts showed opinions varying from 7,000 to 20,000 lb. per bolt, but the committee considers that bolts should be kept as tight as possible while still permitting of expansion and contraction movements of the rails.

Maintenance of way and structures

Developments in the use of machinery on track maintenance, reviewed by the committee on maintenance-of-way work equipment, included pneumatic and electric rail grinders, ballast-cleaning machines (large and small), snow-melting devices for switches, weed-destroying equipment (plows, chemicals, burners and mowers), and a wide range of uses for light tractors in grading, handling snow and supplying power for track tools. A report on paint-spraying equipment and organization for bridge and other work included a review of the hazards to the men and of government regulations on such work. Another subject was the use of electric and oxy-acetylene welding for building up worn rails, frogs and switches in the track, as well as for strengthening bridges and structural steelwork. This subject was reported upon also by the committee on track, which stated that in the reconditioning of worn frogs and rail ends, the acetylene welding is done generally by company forces, while electric welding is done both in this way and by contract. For the protection of track and bridges against corrosion by brine dripping from refrigerator cars, the committee (in collaboration with the mechanical division of the American Railway Association) recommended a higher degree of maintenance for the tanks and fittings of such cars and better protection of the track and bridges, as no economical means of preventing these drippings by brine containers appears to be practicable.

Supplementary to these maintenance reports was that of the committee on economics of railway labor, submitting for the Manual an outline of methods and forms for the annual programming of work on bridges and structures, together with revised plans of outfit cars or camp cars for gangs employed on maintenance-of-way and structures. All these were adopted. Its report on methods of reducing work-train service, as practiced on various roads, showed reductions of 20 to 75 per cent by the use of such means as local freight trains, track motor cars and off-track equipment, giving corresponding reductions in the interference with regular train service.

Research for the Railways

CALLING the railroads the greatest single agency making for national unity, A. A. Potter, dean of engineering, Purdue University, in an address at the annual meeting of the American Railway Engineering Association, outlined a broad-visioned program of research which would help them to maintain and continue this responsibility. He recommended a central research laboratory that would not invade the field of the individual railroad test department and would supplement the laboratories of the equipment companies.

The fact-finding agencies in connection with railroading, said Dean Potter, include equipment manufacturers, individual railroads and the American Railway Association. To the manufacturers he noted credit in the past decade for increasing markedly the power output per driving axle and a reduction of 20 per cent in fuel consumption per passenger-train car-mile and of nearly 30 per cent per ton-mile of freight handled. Great strides have been made in electric locomotives, in internal-combustion rail cars and in diesel electric locomotives for special service. Noted also were savings in car weight by welded steel construction and light materials, improved air brakes, more effective bearings and superior lubrication, improvements in car wheels, automatic couplers, draft gears, and special equipment for engine repairs and for the upkeep of tracks and structure and in signaling.

Individual railroads were credited largely with developing in their own laboratories many recent advances in air-conditioning, pre-cooling of sleeping cars, improved bearings, streamlining and lightweight trains and improved locomotive performance. But this results in useless duplication of effort.

More than half of the $6,750,000 fact-finding expenditure of the American Railway Association over the past eleven-year period was devoted to the mechanical division. A part-time director is in charge of this division, while the other divisions are largely directed by committees, mainly concerned with operation. Members of the committees are usually selected because of geographical distribution or availability, and even favoritism has been known to guide their choice rather than specialized knowledge or outstanding research ability. Existing troubles get attention, rarely new problems or novel methods, and rarely consideration of developments outside of railroading. Great credit was given the A.R.E.A., which acts also as the engineering division of A.R.A., for the present rail section and for basic investigations, on rails, grade-crossings and stresses in railroad track.

Whatever good the experimentation, standardization and practical research has done, Dean Potter held that greater accomplishments might be possible if the railroads gave more attention to basic scientific and business research under competent centralized direction, mutually supported by all the railroads. Suggested problems are as follows: better riding qualities, improved ventilation, greater cleanliness and reduction of noise for passenger cars, elimination of shock in train-handling, mechanical study of springs, dynamic balancing of more powerful high-speed motive power, improved prime movers of superior fuel economy, better light alloys, new uses and applications of the findings of science and experimentation with types of equipment leading to different operating procedure. Business and human research problems should be included. Such non-technical problems would be the basis for study of rates and fares, traffic policies, railroad financing, wage scales, operating-cost studies, public relations and coordination with all types of transportation.

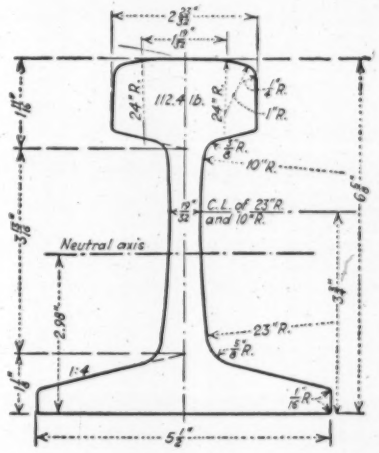
The railroads have devoted only about one-hundredth of 1 per cent of their operating income for the last eleven years to the creation of new knowledge, as compared with expenditures of 1 to 4 per cent for research in the case of progressive industries. The A.T.&T. has spent annually $8,700,000 during the past four depression years out of a gross of one billion per year. The Aluminum Company of America has been devoting 1 to 4 per cent of its gross, and the DuPont Company 1½ to 4 per cent of its net income to similar work.

In conclusion, Dean Potter said of railroad research: "So far as they have gone, the results have been excellent, but railroad research, particularly of the basic type, has not been carried out on a scale which its importance for railroading deserves. Too large a proportion of past research efforts has been directed to old problems and too little to those of the future."

Standard Rail Joint Adopted by A.R.E.A. for New 112-Lb. Rail

DESIGN of a standard form of rail joint to supplement its standard rail sections is a new departure for the American Railway Engineering Association, but such a joint was submitted by the rail committee with the recommendation that it be adopted. The specific design is for the new 112-lb. rail section that was adopted in July, 1933. At present the association's manual recommends nothing more as to joints than a uniform spacing of 5½-in. for the bolts. The joint design was sent out with a letter ballot in January, 1934, and was adopted by a vote of 444 to 160, as announced in a supplementary bulletin dated March 5. This bulletin further presented a design of the same type of joint for the standard 131-lb. rail section.

FIG. 1—NEW STANDARD 112-lb. rail, replacing former 110-lb. rail, presents advantages in design.



The new 112-lb. rail section (Fig. 1) adopted by similar short-time letter ballot in July, 1933, is intended to replace the 110-lb. section now in the Manual, and to give a rail of weight between the present 100-lb. and 131-lb. standard sections. This 131-lb. section was also a modification of a previous design, superseding the former 130-lb. section, as explained in *Engineering News-Record*, March 30, 1933, p. 412.

As to the proposed rail joint for the new 112-lb. rail, it will be seen from Fig. 2 that the splice bars are not of the angle-bar section but conform rather to the fish-plate type, reinforced by heavy ribs along the top and bottom edges. Both 24-in. four-bolt, and 36-in. six-bolt joints are provided for. The spacing is 5¾ in. for the middle bolts and 6½ in. for the others. This is at variance with the present recommenda-

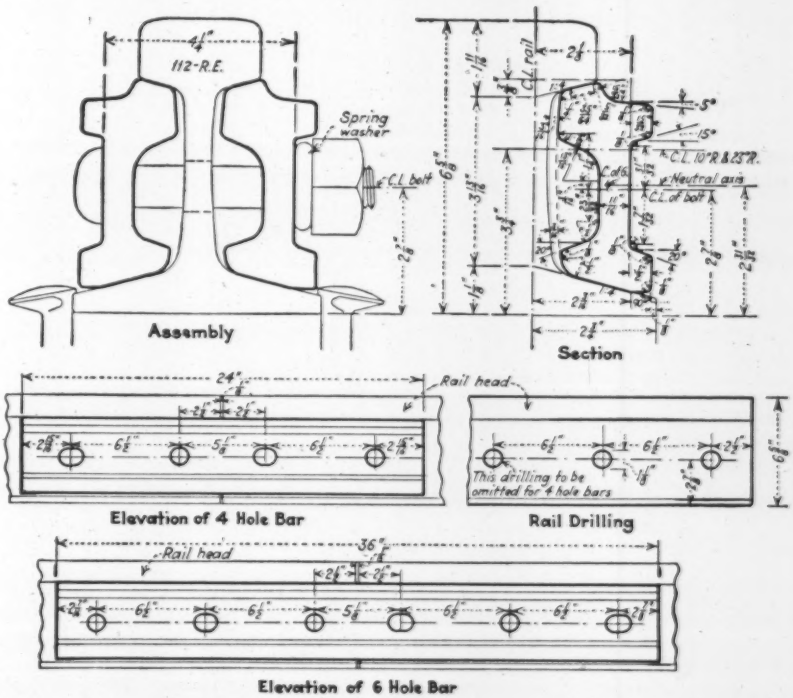


FIG. 2—ADOPTED standard rail joint for 112-lb. rail provides for both four-bolt and six-bolt joints.

tion for a uniform spacing of 5½ in., as given in the Manual. For a pair of bars the combined sectional area is 11.34 sq.in. and the weight per pair is 75.4 lb. for the 24-in. and 113.2 lb. for the 36-in. length. For the ⅞-in. bolts, with oval necks, the holes in the rails are to be 1⅛ in. in diameter, while those in the bars are to be alternately 1 1/16 in. in diameter and 1 1/16 x 1⅛ in. oval. It will be noted from the drawing that the spikes in the joint ties are reversed, as the shape of the splice bars prevents the spike heads from taking a bearing on the base of the rail.

An abstract follows of the rail committee's report and ballot statements, but it will be noted that no explanation is given as to the basis of design of the splice bars or the change in bolt spacing:

In designing this new [112-lb.] section, no change was made in the width and thickness of base, as compared with the 110-lb. section, so as not to affect the interchangeability of tieplates, rail anchors and the pre-boring of ties. No change was made in the width of head at the gage line at ⅝ in. below top of head. The desirable increases of the 112-lb. section [shown in the accompanying table] are secured with comparatively small increase in weight. It is intended that this will be the only section between the 100-lb. and the 131-lb. sections, and therefore its weight might properly approach the halfway point. Consideration, however, was given to the desire of users of the 110-lb. section not to increase the weight to any great extent. Within reason, the weight was permitted to fall where it would, as the result of the rail dimensions agreed upon. The distribution of the metal of the head, web and base for this section falls between that of the present 110-lb. and the 131-lb. sections, both of which have been successfully rolled. The Manual is to be revised to conform to the new sections and also to increase the diameter of the bolt holes 1/16 in. The present adopted diameter holes in the rail is only 1/16 in. larger than the bolts, which is insufficient to provide proper clearance for expansion or the admission of the bolts without probable damage to the threads. The proposed revisions conform closely to current practices on the majority of the roads.

The betterment of the joint bars is one of the most important considerations and ranks with the improvement of the rail section itself. Any increase in the fishing depth of the rail increases the stiffness and strength of the joint bars. There is not much opportunity to secure these increases by widening the joint bars.

NEW 112-LB. RAIL ADOPTED BY A.R.E.A.

	110-lb. Rail	112-lb. Rail
Stiffness (modulus of inertia)	100%	115.5
Strength (section modulus)	100%	108.1
Weight of area	100%	101.8
Area of head	37.4%	35.9
Area of web	23.0%	25.1
Area of base	39.6%	39.0
Ratio moment inertia to area	5.27	5.97
Radio section modulus to area	1.55	1.64
Ratio base to height	0.88	0.83
Moment of inertia	....	65.8
Section modulus, head	....	18.1
Section modulus, base	....	22.1
Area, head, sq. in.	....	3.96
Area, web, sq. in.	....	2.77
Area, base, sq. in.	....	4.29
Area, total, sq. in.	....	11.02

Contractors' Responsibilities Begin Under the NRA Code

Starting last Monday, every contractor must be registered, and 0.1 per cent assessment must be paid—A.G.C. chapter offices temporarily will represent the Code Authority locally

By Edward J. Harding
Secretary, General Contractors' Divisional Code Authority, Washington, D. C.

AFTER MONTHS of negotiations and toil in perfecting the code of fair competition to govern the General Contractors' Division of the construction industry (Chapter II of the Construction Code) and in securing official approval, this branch of the industry is now embarking upon the third and most important phase—active administration of the code. March 19, the effective date of the General Contractors' Divisional Chapter II, marks the beginning of a new era of relationships, responsibilities and rectitude for every general contractor in the country. From that date on, his relationship with awarding authorities, labor, fellow contractors, subcontractors and material men must conform with those standards which the vast majority of this industry has accepted, with the approval of the national government.

In preparation for administering Chapter II of the code, the executive committee of the Associated General Contractors of America met at Washington on March 3 and appointed twelve members of the A.G.C. to the General Contractors' Divisional Code Authority. These twelve members met March 6 to appoint five non-members to the Authority, as provided for in Sect. 1, Art. II, Chapter II, completing the Authority to its full strength of seventeen. The Authority organized on March 10, naming four officers headed by A. E. Horst, chairman. The full list of officers and members was published in *ENR*, March 15, 1934, p. 366. In addition to the names of those previously published, Louis W. Hickey, of Dallas, Texas, has been named executive manager, and the firm of Hayes & Hayes, Washington, has been appointed general counsel.

With its organization perfected, the Authority immediately turned its attention to the procedure of registering every agreement entered into on and after March 19 by general contractors for work or services exceeding $2,000 in value, as authorized by Art. II-A, Sect. 2-b of Chapter II. The Authority also decided that an assessment of one-tenth of 1 per cent should be levied on the value of all such agreements or contracts, and that this assessment should be payable to the General Contractors' Divisional Code Authority, which body is to make the necessary distribution among the other administrative agencies involved.

The necessary forms and procedure to accomplish this registration and collection of assessments are being rapidly developed and undoubtedly will be approved and ordered put into immediate effect at the next formal meeting of the Authority, to be held in Washington on March 24. In the meantime, every general contractor entering into any agreement for work or services on and after March 19 should be prepared to give full information on same for registration purposes, and should anticipate payment of the assessment.

To secure proper registrations, the Divisional Code Authority has designated the Associated General Contractors as its agent to secure the registrations and remittance of the necessary fees. The A.G.C. will immediately utilize its branch and chapter offices throughout the nation for this purpose until such time as local and regional administrative agencies have been permanently established by the Divisional Code Authority.

Steps are now under way toward canvassing the United States, so the Divisional Code Authority may be in a position to make selections for such local and regional agencies. The Authority is now contacting NRA to secure application forms for labor and other provisions which the Administrator has required to be posted by all members of the industry. These application forms will be distributed and, upon return, the required number of the labor provisions will be sent to the individual firms. These too will be furnished by NRA to the Divisional Code Authority.

Chapter offices of the Associated General Contractors will be used as functional agencies in this work. In order that the contractors may comply with the President's executive order requiring compliance forms to accompany bids on all work involving federal funds, the Divisional Code Authority is cooperat-

ing with NRA to obtain supplies of these, which will be made available through local organizations as soon as possible.

Requests for explanations of the terms of the code are being referred to the Divisional Code Authority for its consideration, and will be answered individually or by general instruction, as the Authority may determine.

The provisions of the subchapters II-A, II-B, II-C (governing building, heavy construction and highway contractors, respectively), provided for in Chapter II, the general contractors' division of the code for the construction industry, are progressing rapidly and will be presented to the Administrator through the Divisional Code Authority in the near future. However, it is to be understood by those within the industry that these subchapters will be by way of modification and expansion of Chapters I and II, and, until approved by the Administrator, the provisions of Chapters I and II will continue to apply to all members within the respective definitions.

The mechanics of administration, which, while naturally of great interest to the contractor in the field at the present moment, are of minor importance compared with the individual spirit of compliance and cooperation in administration that must be developed. While we cannot at this writing lay down hard and fast rules as to just what steps an individual contractor must take toward the registration of his contracts, the payment of his assessments and the like, we can and do urge him to familiarize himself thoroughly with the fair-practice provisions of Chapters I and II of the code and to live up to them faithfully. This means that all of those abuses which in the past have brought contumely upon the industry must be foregone by each and every general contractor individually. Bid shopping, bid peddling and secret rebates can be tolerated no longer—it is each general contractor's responsibility to see to it that they are not.

The general contracting industry is getting an absolutely new start under the code. What it makes of it and the extent of administrative policing will depend largely upon the attitude of its members. The General Contractors Divisional Code Authority has no intention of bearing down on the contractor who is conscientiously endeavoring to comply with the industry's charter of self-regulation, but it does propose to see to it that the granting of that charter is justified.

Letters to the Editor

After CWA, What?

Sir—Construction is the paramount necessity today, the one most important link in our recovery program. Construction will put the unemployed back into useful occupations, which in turn will put money into circulation, stimulate buying and trade, bring about the demand for tools, supplies, equipment, and thus incidentally start manufacturing on a larger and sounder basis. It is true that this is just what is being done, but it isn't going far enough or deep enough to keep the chart line up to its normal curve—it is still sagging dangerously in spots.

Just what is lacking? Weren't we over-constructed in 1928 and 1929? Undoubtedly we were over-constructed, over-manufactured, over-mined and over-produced along many lines. In the cities we were building skyscrapers and subways, to remain tenantless or unfinished for many years. In the mines we were mining and selling our products on a cut-throat competitive basis. The farmers were raising wheat and corn to burn, and pyramiding the mortgages to do it with. And yet it wasn't construction so much as the pyramided loads it had to carry. It wasn't construction so much as its sudden stoppage that broke down the machinery of commerce and left us facing starvation in the midst of plenty and penniless just outside of banks reeking with frozen assets that only recently had represented over-surpluses.

Almost the first progressive step of the new administration was the passing of the Recovery Act. More than three billion dollars was appropriated to start construction, and great things were expected. There is one thing sure: without this PWA appropriation we would have faced revolution perhaps and possibly chaos. But the trouble was that the business of putting this money to work got into the hands of efficiency experts. They said: "Our government is ready to loan you money to carry out this project at a low rate of interest, and it is even ready to give an outright grant of 30 per cent." But—the plans had to be ready to start work immediately, and there were numberless other items involving red-tape entanglements; also the project engineers were advised to see that the prime feature of any project was its value from the standpoint of efficiency rather than its practical utility.

But this did not deter many engineers from going ahead preparing projects for listing under the act. Some of them actually got under way. Projects like the San Francisco Bridge, the 38th St. Tunnel in New York, the Triborough Bridge and others whose plans had been previously ready for submission progressed to the point where they are now actually under construction contracts. But when it came to other and newer projects, especially those running into the higher brackets of cost, it was found there were more serious matters of red tape, such as franchises, charters, permits, etc. The engineer could prepare the plans and cut most of the ordinary red tape, but he could not convene a legislature to grant a franchise nor prevail upon a municipal government to permit consideration of the plan until its own engineers had spent months in further exhaustive study.

Meanwhile, the winter was approaching, and it was seen that very little actual construction work would be available for the eight or ten million unemployed. The President again stepped into the breach with the temporary CWA. This was a most worthy expedient for putting men into construction work. But what is going to follow it?

My own idea is that the only possible solution lies through an early and further appropriation to the PWA of perhaps two billion dollars, carrying with it a proviso for liberalizing the method of making loans under it. It is not necessary to change the act or the law to give this appropriation, if made, immediate constructive value.

From the rules prescribed by the President of "the purposes, policies, functioning, etc., of the Emergency Administration" in Circular No. 1 of July 31, 1933, p. 14, is found the following example: "Case No. 4. The applicant has no borrowing margin. In this case the leasing provisions of the act may be most convenient as where the applicant has power to sell sites and/or lease projects, or there is reasonable prospect that it will promptly obtain such power. In said situation the United States may acquire title, and the improvement may be constructed thereon by the applicant with funds provided by the United States."

This apparently indicates clearly that Uncle Sam may acquire title or lease to the project and build it with his own funds, holding it until such time as the state or municipality could re-acquire and take over the project. This means: (*a*) good business for Uncle Sam; (*b*) work for the unemployed; and (*c*) the consummation and construction of much-needed and, in most cases, high-class, self-liquidating projects on a large scale.

An appropriation of $2,500,000,000 under a liberalized schedule and under the shorter hour work week would take care of a fairly large percentage of the unemployment caused by discontinuance of the CWA. Otherwise, what? It gets down to one paramount necessity—Construction.

J. C. MEEM,
Civil Engineer.

Brooklyn, N. Y.,
March 10, 1934.

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March 22, 1934

The Way Out

RESEARCH has proved to be the way out for many industries. Is is also the way out for the railroads? Dr. Karl T. Compton, wide-awake president of Massachusetts Institute of Technology, said so most emphatically last June, when at the Engineering Week dinner at Chicago he indicted the railroads as being backward in research. Dean A. A. Potter, of Purdue, restated the charge a week ago in addressing the American Railway Engineering Association at its annual meeting. His comparisons of railway research budgets and achievements with those of industries that are active in development study—he singled out the telephone and aluminum companies particularly—were not flattering to transport progressiveness. Moreover, he said, past work has largely concerned itself with problems of existing equipment and methods and has ignored the function of research to develop new ideas and draw on the advances made in other industry fields. Research should take a view of transportation as a whole, he suggested, and its studies should be extended to business and human problems. Bearing in mind the magnitude of the task he thus assigned to research, his proposal of a central research laboratory appears concrete and promising. Competition is a hard taskmaster; it has taught many businesses the value of research, and others the value of cooperation. Perhaps the two lessons in combination—cooperative research in transport technology and economics—can bring some help to the railroads in their present difficulties.

Winter Work

CONTRACTORS and public officials have made strenuous efforts to keep winter work under way, according to a survey of three cold-belt states—New York, Michigan and Wisconsin. Their efforts would have been highly successful in a year of normal winter weather, but extreme temperatures prevailing for weeks at a time thwarted the best of purposes. Concrete bridge work, in general, fared well; cold weather found contractors prepared for the worst, and simple heating and protection methods were effective in forestalling interruption of operations. Some river jobs were delayed by running ice. Road construction suffered most, for continued cold carried the frost down as deep as 36 in. in places. Excavating and grading clay materials under such conditions is impossible. But work was not shut down on some jobs until after dynamite had been brought into use and equipment literally torn to pieces in an effort to keep going. Public officials adopted a lenient attitude despite contract schedules, knowing that good roads cannot be built of frozen materials. However, the experiences of this winter will be of high value for use next winter, as they emphasize the need of careful planning and selection of winter projects and point out anew the types of work that can and cannot be carried on in extreme cold weather. As spring approaches, time lost will be made up, but credit is due all round for the efforts made to keep men at work in the face of heavy odds.

Highway Employment

THE AMOUNT AND VARIETY of employment that has been obtained through the emergency road program is full and adequate justification for the inclusion of a large highway appropriation in the National Industrial Recovery Act. Argument is hardly needed where the factual evidence is so plain and indisputable as in the record of highway employment published in this issue. The emergency highway appropriation has accomplished the objective of providing quick employment on a large scale, and road engineers have the duty of making the fact known to all. The public and the legislatures have to be told that for every 1,000 continuous jobs 1,800 men are given work for some period of time, and that for every 1,000 men directly employed on the road 1,500 others are given work in mine, quarry and factory and on the railroads. These and other facts well known to the engineer must be made equally familiar to the legislator and road user if he is to support the current demand that highway employment be continued with another federal grant—and that, if possible, the regular federal aid be resumed. Employment under the emergency road program will end before the close of the current year. By November not a third of the million and a quarter highway jobs of midsummer will remain. This is a discouraging outlook for the beginning of the winter of a fifth depression year. If the organizations of highway men and highway industries are to justify their claim of service to highway transport, they assuredly should enter on an immediate course of action to keep the broad employment of road-building going.

The Center of the Stage

BRIDGEBUILDING INTEREST during the next few years will be centered on the San Francisco region, where the Golden Gate span and the Bay Crossing will both be in the active construction stage. The latter project, in many respects, is the most ambitious bridgebuilding enterprise ever undertaken. It will cost more than any of its predecessors. It contains two suspension bridges, placed tandem, whose main spans are longer than any attempted prior to the George Washington Bridge at New York. It contains a tunnel, larger in diameter than even the Boulder Dam diversion tunnels. It contains a cantilever span that has been exceeded only twice. And, excepting only some concrete-pile trestles, it is the longest bridge crossing yet attempted. The evolution of its design, presented in this issue, is therefore of major consequence. For this bridge is destined to advance engineering knowledge and achievement just as every great project has done in the past.

Wage Discrimination

IN THE WEEK'S portentous happenings in the labor field, which include strikes, threats of strikes and further manifestation of the NRA's vacillation in labor policy, one significant event goes quite outside the range of discussion as between labor-organizer racketeering and employer autocracy, and pierces to the core of a major economic sore. It is the retort of the railway labor groups

to the roads' proposal for continuing the 10 per cent wage cut now in force (or increasing it to 15 per cent) on the ground that revenues will not stand a restoration of the former basic wage. The labor representatives argue that the roads in fact made large profits during the depression, even during 1932 and 1933, and that the apparent losses are due only to the large wages paid to invested capital—this capital being kept mainly in the form of bonds under traditional railway financing practice. Half a billion dollars of such capital wages was paid every year, it is stated, even in the black year of 1933. Capital hire has traditionally been held to be a "fixed" charge on earnings, while labor hire is controlled by what is left; and through this wage discrimination in the case of the railway workers the large majority are forced down into the class of "lowest-income workers" —the class which, it has been admitted, cannot even be provided with tolerable housing under present conditions—and in addition many thousands of veteran workers were thrown out of employment during the depression, to go on relief or starve, while the employment of capital continued throughout and its wages were kept at peak level. This accusing retort of the railway workers throws a glaring light on those surviving corporate practices which refuse to admit that capital ever becomes idle and that therefore impose the full strain of business variation on labor. It has long been clear that banker management kept the railroads under the sway of these ancient ideas, and that in this fact may be found the root of the railroads' troubles. But only the last few years have brought proof that the practice endangers the security of money quite as much as the security of workers and the industrial organism. Fortunately, a large part of business and industry has long been operated on sounder principle. The many businesses that operate mainly or wholly on a stock basis and that, by paying no dividends, demonstrated that capital can take it even better than labor, were a big factor in carrying the nation through the depression. And none of them borrowed money to continue capital wage payments.

Construction Self-Government Begins

WITH the present week the construction industry enters the era of self-government under the rules of the NRA code. The change from past conditions is profound. Commercial and contract practices that heretofore were subject only to individual conscience and the rule of expediency are now controlled by law. Though the law was framed by the industry itself it is none the less law—not, as some believe, a set of ethical precepts but a penal statute fully as binding as though it had been enacted by Congress directly.

Though the basic evils of bid-shopping, bid-peddling and related acts of bad business faith were outlawed on March 2, when Chapter I of the code, containing the general provisions on scope and fair practice, became effective, the law lacked enforcement machinery. Now, through the processes and the Divisional Code Authority of general contracting under Chapter II, which went into effect on March 19, enforcement is at hand.

But the code is in fact a great opportunity rather than a restrictive measure. It gives construction a new freedom. Only the unsocial, destructive actions that have wrought injury to all are restrained, while a broad avenue of progress is opened up. Construction is placed in position to put its house in order—to clean up bad internal conditions and to render better service to its clients. And herein, obviously, lies the hope of the industry.

The operation of the code, then, is in everyone's interest, and its support and enforcement are everyone's business. If we would realize soon the large gains it offers, the cooperation of every member and element of the industry is essential—engineer, contractor and subcontractor alike.

First of all, after the routine preliminary of bringing about universal registration of construction operations, is the task of assuring observance of the labor provisions, preventing chiseling, and stamping out the uneconomic and unethical practices that have been made unlawful by the code. Next, and as soon as employers and labor can get together in the various regions, comes the formulation of area agreements on working conditions. Finally there is the broad problem of studying the industry's operations with a view to improvement of its practices and laying the foundation for adequate planning. The objectives are safety, economy, elimination of losses and wastes, and above all the coordination of construction with the country's real economic needs.

One of the early steps toward successful operation of the code is to establish definite labor relations. Labor agreements have already expired in many places; others will end May 1. Area and local agreements can be made, none of which will affect or will be binding on other areas or localities. Experiences of other industries operating under codes prove the need of mutually satisfactory labor agreements.

Clearly it is important that we should reach as quickly as possible a full understanding of code obligations and procedure, so that everyone may be able to adjust himself to it and join in making it truly effective. For his own protection, if nothing else, each individual contractor and engineer should at once acquaint himself in detail with the meaning of the code provisions. He must know that every construction operation down to the $1,000 job is covered by the code, that every housebuilder is a "member of the industry," and that even before the subcontract chapters of the code come into force the rules of fair play and even-handed competition have become the law for all bidding, contracting and subcontracting.

Under the code, every contract of $2,000 or more must be registered, and a fee paid to the divisional authority toward the cost of code administration. The corrupt practices of bid peddling and shopping, chiseling and rebating are banned. Uniform accounting procedure may be established. Contractors are to be properly qualified by capital, organization and experience. Provision is made for the establishment of labor agreements. Hours of work are limited and minimum wages are set. These are but a few of the regulations and restrictions affecting every contractor. To enable them to be understood and applied with least delay, E. J. Harding in this issue explains for the Divisional Code Authority how the code will begin to function.

The leaders of the industry in each of its departments are united in the will to make the code a working success. If their efforts are backed by the cooperation of all, industrial self-government can be achieved, to the profit of construction and the community alike.

CURRENT NEWS

Code Authority to Sponsor Names for Adjustment Board

THE CONSTRUCTION CODE AUTHORITY at its meeting in Washington on March 23 will nominate ten representatives of employers to the National Construction Planning and Adjustment Board. Selection will be made by the Industrial Advisory Board of NRA, subject to the approval of the Administrator. It is understood that labor organizations have already nominated ten employee representatives to the Labor Advisory Board of NRA which makes the selection also subject to the approval of the Administrator. The Code requires that the Board be established within thirty days from March 2.

Revised regulations were issued Feb. 28 by the Administrator, requiring all employers to register with their code authority. After enrolling they will be furnished with official copies of labor provisions to be posted in their establishments and, in the case of construction, on the job. In the construction industry it is proposed to carry out this registration through divisional groups, by the divisional code authorities where established, or otherwise through the national trade associations sponsoring the divisional chapters. Final approval of the plan will be made at the meeting of the Code Authority on March 23.

No additional divisional chapters have been finally approved during the past week, but approval is expected soon on the Cement-Gun Contractors Chapter and the Elevator Manufacturers Chapter. The Roofing and Sheet Metal Chapter and the Electrical Contracting Chapter are next in line for approval.

TVA Extends Stream Gaging and Orders Concreting Equipment

Fifty additional stream gaging stations have been established by the Tennessee Valley Authority on the main river and tributaries above the site of the Norris Dam. The establishment of these stations is to enlarge the scope of the hydrological studies of the valley and, in addition, provide 40-hour advance information of approaching flood stage during the construction period at the Norris Dam.

Orders totalling $293,693 for the purchase of a floating concrete mixing plant have been placed by the TVA for the construction of the Joe Wheeler Dam. The mixing plant will be mounted on barges to facilitate construction operations since the Tennessee River at the dam site is more than one mile wide. Each of the four mixers will be mounted on a 40x90 ft. steel barge.

John L. Neely, Jr., Nashville, Tenn., has been appointed manager of TVA activities in the Muscle Shoals area, according to an announcement of the Authority directors.

St. Lawrence Waterway Treaty Fails to Receive Required Votes

The St. Lawrence Waterway treaty failed to receive the necessary two-third majority of those voting when it came up for ratification by the U. S. Senate on March 14. A scant plurality, 46 to 42, favored the treaty. President Roosevelt, in commenting on the failure of the treaty to pass the Senate, expressed confidence in construction of the waterway ultimately, also indicated his belief that Canada might build the waterway entirely within her own borders, charging tolls for the passage of American ships.

Geographical distribution of the votes indicates that every State on the Atlantic and Pacific coasts and on the Mississippi River contributed votes against the treaty. Coal states, confronted with the possibility of the development of a vast amount of hydro-electric power, also contributed to the defeat of the treaty.

Failure of the treaty to pass the United States Senate means that it will not be submitted to the Canadian Parliament for ratification. Opposition to the treaty exists there also, the geographical distribution being similar to that in this country. Within the last few days the board of trade of St. John, N. B., in a resolution forwarded to the dominion parliament, expressed strong opposition to ratification of the treaty. The board of trade stated that Canada is confronted with an acute railway problem involving deficits that are continuous and staggering, a problem further accentuated by the waterway.

Compliance With Codes Required on All PWA Work

ACTUAL COMPLIANCE with NRA codes on all Government contracts and contracts involving the use of federal funds is required by an executive order of the President, March 14, including subcontracts and the furnishing of materials and supplies. To be eligible, bidders must file a certificate of compliance. The effect of the President's action is to put a stop to the award of contracts on low bids that, under a ruling by Comptroller General McCarl, were accepted regardless of the bidder's compliance with the appropriate code or reemployment agreement. The President's order also applies to all contracts and purchase orders by states, municipalities, local subdivisions, persons and corporations in connection with projects financed wholly or in part by a federal agency, such as the Public Works Administration.

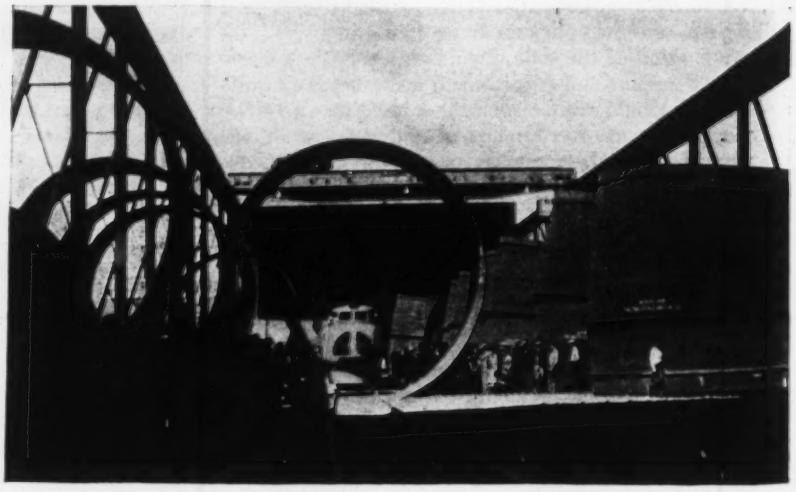
No conflict is seen by PWA between the President's order and the PWA requirements for bidders. Furnishers of equipment, materials and supplies on PWA projects are now required to comply with the appropriate code or reemployment agreement. Labor employed directly on the project is subject to the 30-hour week and minimum hourly wage rates of $1, $1.10 and $1.20 for skilled labor and 40c., 45c. and 50c. for unskilled labor under the agreement of last August

(Continued on p. 398)

STREAMLINED TRAIN VISITS PENSTOCK PLANT NEAR BOULDER CITY

Rapid progress is being made in fabricating the 30-ft.-diameter penstock pipes for the Boulder Canyon project. The view below, taken on March 9 when the new streamlined train of the Union Pacific Railroad paid a visit to Boulder Dam and vicinity, permits ready appreciation of the size of the penstocks.

The section through which the train is passing is 12 ft. long, of 2¼-in.-thick plate and weighs about 75 tons. Two such sections shop-welded together will constitute the usual-size erection piece, although some of the special branch sections, such as those shown at the right, will weigh as much as 185 tons. At this fabricating plant (*ENR*, Dec. 21, 1933, p. 751), located about 1½ miles back from the canyon rim, the Babcock & Wilcox Co. is transforming some 45,000 tons of plate into pipe by means of arc welds which are laid by automatic machines, X-rayed by special equipment and annealed in a huge furnace.



Contract Awarded For Vehicle Tunnel Under Hudson River

CONTRACT for the construction of the under-river section of one tube of the Midtown Hudson Tunnel, the second vehicle tunnel to be built under the Hudson River at New York, was let by the Port of New York Authority on March 20 to Mason & Hanger Company, Inc., New York. The Mason & Hanger Co., submitted a low bid of $6,452,300 when bids were opened on Feb. 21. Details of the bids were published in our issue of March 1, p. 304, and a description of the proposed tunnel was published in the issue of March 8, p. 313.

The contract let to Mason & Hanger calls for construction of about 6,000 ft. of the south tube of the projected two-tube tunnel as a shield-driven tunnel from the New Jersey ventilating shaft, 1,000 ft. west of the bulkhead line, under the river to a construction shaft on the south side of 39th St. in New York between 11th and 12th Avenues, also construction of the substructure of one ventilating shaft each side of the river and 60 ft. of rock tunnel west of the New Jersey ventilating shaft.

Contract for the cast iron and cast steel segments for the shield-driven tube was let to the Bethlehem Steel Co. on Oct. 19, for $2,358,150, and a contract for the high-tensile strength steel bolts was let to the Oliver Iron & Steel Co., Pittsburgh on Dec. 5 for $177,664.

Construction of the tunnel is being carried out by the Port of New York Authority.

Better Location Found for Bonneville Dam Spillway

The plan to move the spillway section of the Bonneville dam, now under construction on the Columbia River, to a better site will save at least $2,000,000 in the cost of the project, according to a reported statement of General George E. Pillsbury, assistant to the chief engineer. Final approval for the change has not been issued. The change has been contemplated for some time and results from thorough exploration of the new site and comparative design studies. The original location provided the spillway section in the north (Washington) channel at the upstream end of Bradford Island and the change will move this section of the dam about 3,000 ft. downstream to a point opposite the center of the island (*ENR*, Nov. 9, 1933, p. 557).

Excavation for the spillway section at the original location was the first major contract let on the project and was well under way when interrupted by unusual floods last December. The need for the work to be done under that contract is now eliminated by the change in site and, according to reports, the contractor will be reimbursed for the work done and the necessary adjustment made on the contract. The contract was held by the General Construction Co., Seattle, Wash.

Work on the Guy F. Atkinson contract for the excavation of the powerhouse and lock site in the south (Oregon) channel is going forward rapidly.

Grand Coulee Development Becomes Federal Project

The Grand Coulee development on the Columbia River in central Washington which will be exclusively a hydroelectric power development in the initial stage, has been declared a Federal project and will be built and operated by the government, according to an announcement of the Public Works Administrator, Secretary Ickes. Originally, this project was to have been a state-controlled development subject to a contract executed between the state and the United States covering the arrangement for repayment costs through the sale of power by the state to new and existing agencies. The project has been reconsidered by the PWA and the recent resolution approved by the Administrator and the Special Board of Public Works places the project under the control of the Bureau of Reclamation. Construction of the project would be carried out by the bureau according to either plan.

An allotment of $15,000,000 has been made to the bureau to finance the construction of camp facilities, the erection of a bridge across the Columbia River at the damsite and other preliminary work. The plans for the $40,000,000 dam are now under preparation in the Denver office of the bureau and it is expected that bids will be called for by May 1.

Water Tunnel Contractor's Claim Against Baltimore Settled

The Public Improvement Commission, Baltimore, Md., has announced settlement of a claim of $477,901.02 filed with it by the Whiting-Turner Construction Company. Settlement was made, it was announced, for $57,809.42.

The claim was filed in connection with the construction of the Montebello-Druid Lake water tunnel, the contract price for which was $1,145,000. It was based on the claim of the contractor that quicksand had been encountered on a part of the work. The claim was before the commission for several months. The tunnel involved is an 84-in. connection between the filtered-water reservoir at the Montebello filtration plant and the Vernon pumping station at Druid Lake, 13,500 ft. long.

Colorado Organizes State Planning Board

At the request of the National Planning Board Governor E. C. Johnson has named a state planning board of eleven members with several engineers including R. C. Gowdy, chief engineer, Colorado & Southern Ry., M. C. Hinderlider, state engineer, and C. M. Lightburn, valuation engineer, D. & R. G. W. R.R. The board, headed by John T. Barnett, has been furnished with a planning consultant, Irvin J. McCrary, Denver, by the National Planning Board. A CWA project has been set up and a program outlined covering the following subjects: Land utilization, transportation, conservation of water resources, public works, industrial development, mineral resources, public lands, marketing, sanitation and health, recreation, population and social survey, housing and slum clearance and governmental reorganization.

Detail Figures on Allocation of PWA Funds

WHERE did the public-works fund of $3,300,000,000 appropriated by Congress last June for recovery purposes go? This frequently asked question is answered by figures just obtained from PWA headquarters. The largest part went for federal department use or for federal projects—if the latter term may be used to include the CWA, the Civilian Conservation Corps, the emergency highway fund of $400,000,000 and the $238,000,000 allocated for warships. These items total $1,371,000,000.

In addition, however, no less than $1,101,000,000 was allocated to federal departments and agencies for a wide variety of uses, including such items as half a million each to the Alcohol Control Administration and the General Accounting Office. Some of the money taken out of the Recovery Fund was assigned to government bureaus to replace money appropriated previously by Congress, but withdrawn by Presidential order, so that it represents normally contemplated expenditures either for construction or for administrative uses.

The total money devoted to federal expenditures, according to the list, is $2,472,333,000. Non-federal projects other than railroad work total $627,959,600, while railroad construction and equipment loans amount to $196,608,000.

An important tabulation gives the distribution of non-federal project loans by classes, indicating that waterworks, sewers and bridges account for more than half, with $364,000,000. The list follows:

Type	Number	Allotment
Waterworks	451	$66,666,972
Sewers	347	133,964,260
Schools	330	62,548,539
Streets and highways	273	40,468,935
Bridges and structures	83	163,530,245
Hospitals	78	27,415,794
Other buildings	171	26,297,870
Power	44	27,258,900
Housing	20	48,771,958
Recreation	12	2,371,620
Miscellaneous	67	28,664,505
Totals	1,876	$627,959,598

In general, the non-federal projects may be classed as quick, since most of them could be completed within a year. However, it may be noted that nearly one-third of the total figure is accounted for by about two dozen large projects whose construction will extend over a considerable period, although contracts may be let within the first year. Among these are the New York tunnel and Triborough bridge, the Camden bridge railway, the Chicago sewage disposal works, sewerage improvements at St. Paul and Cleveland, waterworks at San Francisco, and power and irrigation projects in Nebraska. The average period of expenditure of the non-federal funds thus will be longer than one year.

Federal allotments for CWA and CCC are already nearly spent. The highway fund will be completely spent by early fall of the current year. Many of the federal project allotments represent expenditures extending over several years, notably the warship and irrigation projects.

The railroad loans, according to PWA

estimate, will be spent this year except for possibly $5 millions of the $153 millions already under contract.

SPECIAL ALLOTMENTS

Farm Credit Administration

Agri. Marketing Revolving Fund	$40,000,000
Agri. Marketing Revolving Fund	10,000,000
Agri. Marketing Revolving Fund	10,000,000
Commodity Credit Corporation	3,000,000
Agri Adjustment Administration	37,000,000
Tennessee Valley Authority	41,000,000

Emergency Conservation Corps

Purchase of Land	$20,000,000
Current and Estimated Expenses	303,362,315
Great Smoky Mountain Park	1,550,000

National Industrial Recovery Administration

Administrative Expense	$4,250,000
National Labor Board	500,000
Conciliation Service	15,000
Civil Works Administration	400,000,000

Federal Emergency Relief Administration

Unexpended Balances of Special Account	$901,880
Conciliation Service	5,000
Barter Movement	35,000
Adm. of Petroleum Industry	259,000
Subsistence Homesteads	25,000,000

Federal Emergency Administration of Public Works

Administrative Expense	$6,812,205
Administrative Reserve	25,000,000
General Projects Reserve	35,000,000
National Planning Board	35,000
National Planning Board (Earmarked)	250,000
Public Works Housing Corp.	100,001,000

Other Agencies

Central Statistical Office	$20,000
Electric Home and Farm Auth., Inc.	1,000,000
Executive Council	60,000
Federal Alcohol Control Adm.	500,000
General Accounting Office	506,000
National Emergency Council	310,000
Treasurer, Relief of Contractors	100,000
Interior, Office of Secretary	14,731
Surplus Relief Corporation	25,000,000
Air Conditioning, Public Buildings	1,000,000
Virgin Islands	1,000,000
Emergency Leasing Corporation	1,000
District of Columbia	1,759,500

FEDERAL PROJECTS

Department of Agriculture

Dept. of Agri. Bldg., D. C.	$13,443
Agricultural Engineering	281,538
Animal Industry	1,611,240
Biological Survey	976,050
Chemistry and Soils	103,919
Dairy Industry	262,420
Entomology	153,650
Experiment Stations	4,950
Food and Drug Administration	70,000
Forest Service:	
Control of tree diseases	15,967,745
Forest Highways	15,000,000
Forest Roads and Trails	10,000,000
Plant Industry:	
National Arboretum	386,000
Physical Improvements	3,756,557
Erosion Control Nurseries	630,000
Plant Quarantine:	
Disease Control	2,056,620
Physical Improvement	73,050
Public Roads:	
Public Land Roads	5,015,000
Weather Bureau	183,840
Home Economics	1,200
Public Roads (Statutory)	400,000,000

Interior Department

Repairs to White House	$6,000
Reclamation:	
All American Canal, California	6,000,000
Boulder Canyon Project	38,025,000
Deer Creek—Utah Lake Project	2,700,000
Grand Coulee Dam Project	15,000,000
Moon Lake Reservoir	1,500,000
Owyhee Dam Project	5,000,000
Vale Dam Project	1,000,000
Ellenburg Dam Project	60,000
Parker—Gila Project	100,000
Ronald Dam Project	50,000
Casper—Alcova Project	12,000,000
Reclamation Projects	18,140,000
Sanpete Irrigation Projects	300,000
Physical Improvements	20,000
Verde River Project	4,000,000
Service Division	2,176
Special Account	18,500
St. Elizabeth's Hospital	930,000
Virgin Islands	302,850
Alaskan Railroad	210,000
Alaska Road Commission	1,596,000
Columbia Inst. for the Deaf	10,000
Freedmen's Hospital	85,000
General Land Office	1,000,000
Geological Survey	4,497,164
Howard University	2,294,311
Indian Affairs:	
Physical Improvements	8,058,000
Irrigation and Drainage	6,880,550
Roads on Indian Reservations	4,000,000
Interior Secretary—Soil Erosion	10,000,000
National Parks:	
Physical Improvements	5,668,889
Roads and Trails	24,874,144

War Department

Air Corps (Airplanes)	$7,500,000
Corps of Engineers.	
Flood Control:	
Lower Mississippi	44,120,000
Ohio River	22,590,000
Sacramento River	1,500,000
Winooski River Dam	1,555,000
Rivers and Harbors:	
General	82,118,100
Upper Mississippi	33,500,000
Missouri River	17,753,108
Bonneville Dam	20,240,700
Dam-Fort Peck, Montana	25,000,000
Seacoast Defenses	7,000,000
Insular Affairs	1,500,000
National Guard	2,238,924
Ordnance:	
Ammunition	6,000,000
Quartermaster Corps:	
Housing and Tech. Construction	60,152,765
Motorization	10,000,000
National Cemeteries	592,161
Signal Corps	176,170

Navy Department

Aeronautics	$7,500,000
Engineering	712,500
Ordnance	330,225
Machine Tools	2,100,000
Supplies and Accounts	205,662
Yards and Docks:	
Construction at Shore Stations	24,210,000
Navy Hospital, Philadelphia	2,350,000
Storm Damage	856,985
Construction of Naval Vessels	238,000,000

Commerce Department

Aeronautics	$2,558,803
Coast and Geodetic Survey	6,463,120
Fisheries	558,500
Lighthouses	5,528,334
Mines	272,800
Navigation & Steamboat Inspection	33,043
Standards	100,000

Justice Department

National Training School for Boys	$140,012
Prisons	1,114,500

Labor Department

Immigration	$1,422,980
U. S. Employment Service	500,000
Bureau of Labor Statistics	10,000
Office of the Secretary	10,000

Post Office Department

Departmental	$532,600

State Department

International Boundary (U. S.—Can.)	$26,500
International Boundary (U. S. and Mex.)	4,734,500

Treasury Department

Public Health Service	$2,207,128
Public Works Branch	65,838,103
Coast Guard	25,031,872

Independent Offices

Library of Congress Adition	$2,800,000
Federal Power Comm.	400,000
Nat'l. Comm. for Aeronautics	247,944
Panama Canal	1,000,000
Veterans' Administration	1,916,650
Territory of Alaska	175,500

Federal Bill Would Authorize Cairo Bridge Commission

A bill has been introduced in Congress providing for the creation of the Cairo Bridge Commission, to construct, maintain and operate a bridge across the Ohio River at Cairo, Ill. The bill also provides that all ferries that cross the Ohio and Mississippi Rivers within 10 miles of the location of the bridge would be acquired by the commission. The cost of constructing the bridge would be borne by money received from sale of bonds by the commission. The bill also provides that after amortization of the bonds, the bridge will be turned over to local governments.

Bureau of Public Roads Will Supervise PWA-Built Highways

Supervision and inspection of the highway projects financed by the PWA have been transferred from the inspection division of that organization to the Bureau of Public Roads. This arrangement is intended to serve the double purpose of utilizing the present well organized staff of the Bureau of Public Roads and at the same time permitting the PWA inspection division to devote more time to non-federal construction projects. The list of state and county highway projects which have been transferred to the supervision of the Bureau of Public Roads by this move totals allotments of $31,000,000. These allotments are for projects in addition to those financed from the original $400,000,000 set aside for highway construction.

Washington Notes

By Paul Wooton
Washington Correspondent

The Comptroller General on March 20 released the initial $6,000,000 appropriation for the All-American Canal. Final work on specifications is being rushed at the Denver office of the Bureau of Reclamation. The date of the call for bids and the place of opening have not been determined at this writing.

A new Interior Department building costing $10,000,000, with floor space exceeding 1,000,000 sq.ft., is being planned by Secretary Ickes. The National Park Service has been allotted $2,400 for engineering services in connection with the preliminary planning. The cost will probably come from PWA funds. Secretary Ickes says that the building will be more "practical" than other new federal structures but will not detract from the architectural style of the new development in the Mall.

Secretary Ickes has ordered an investigation of alleged violations of PWA labor conditions on construction work under way at Grand Coulee Dam. He said his attention had been directed to charges of secret payrolls, that workers had been paid by check instead of currency, had been compelled to board at the company's camp and that the hours of labor provisions had been violated.

On March 20 Secretary Ickes telegraphed Governor Bryan of Nebraska accepting, with some revision, the proposals made by the Governor with reference to terms of water rights agreements between the state and the Platte Valley Public Power and Irrigation District on the Sutherland Project, previously allotted a loan and grant of $7,500,000, and the Loup River Public Power District on the Columbus project, allotted a loan and grant of $7,300,000.

He approved one provision worded as follows: "To prevent unfair competition between private and municipal corporations where same are selling for same area, the rates for such area for electric power will be the same for both at the same point of delivery and all such rates shall be satisfactory to the government." Another provision as approved reads: "The breach of any of the conditions herein recited shall be ground for cancellation and revocation

of these water rights in the manner and upon the terms and conditions provided by law." Secretary Ickes refused to accept Governor Bryan's provision prohibiting "lobby" fees and commissions, explaining that no such cost can be charged against these projects except as approved by the Interior Department, that payment will be made only for legitimate services rendered and that these charges will be reasonable and will not add unduly to the costs of the projects. He informed Governor Bryan that if he will eliminate this provision and modify others as suggested above, the agreements will be satisfactory to the administration and immediate orders will be given to proceed with construction.

Concrete Spalling Difficulties on Cleveland Bridge

News reports to the effect that concrete forming the upper deck roadway sub-base on the Detroit-Superior High Level Bridge in Cleveland was "falling in huge chunks" to the lower deck are considerably exaggerated. According to William Blaser, assistant engineer in the country surveyor's office, spalling is occurring due to alternate freezing and thawing of water that finds its way through the asphalt surface and stone block top course of the pavement but it is not yet dangerously serious. As soon as the weather will permit, it is planned to open the sidewalk and pavement at the curb to determine whether the water leakage is taking place at that point. It is also planned to devise, if possible and necessary, a subsidiary system of drainage for gathering the water that seeps through the pavement. The present drainage system takes care of surface water by conducting it to the curb gutters and then to down spouts at the piers. The repair work will also include resurfacing of any openings in the asphalt paving surface and it may also be necessary to renew the waterproofing of the deck. Cleveland has had a fairly severe winter with some extremely wide temperature variations, and this, and not poor design or poor construction, is held to be at the root of the present difficulties.

Work Begun on Third Link of New York's Elevated Highway

Work was started on March 5 on the third section of the superstructure of the West Side Express Highway in New York City, from 38th to 46th Sts. Under the contract the section must be completed within six months.

The link, which is being built by the Poirier & McLane Corp., will cost $1,260,952, of which $209,948 represents the cost of the substructure. A special type of foundation had to be used for this section because of the depth of the fill, it being necessary to go down 80 ft. to bedrock in some places. The proposed 38th St. tunnel forced the placing of footings so that they would not interfere with tunnel construction.

Plans are ready for the fourth link of the highway, from 46th to 59th St., and contracts will be let when funds are available. This will complete the highway from Canal St. to 72d St. The whole roadway, it is estimated, will cost $14,575,000.

Northwest Regional Planning Conference Features Discussion of Power Use

TO PROMOTE a better coordination in the development of all the resources of the Pacific Northwest, for the more complete satisfaction of the economic and social existence for all the people was the general theme of the Pacific Northwest Regional Planning Conference held in Portland, Ore., March 5 to 7, under the auspices of PWA. The conference consisted of an opening general session, followed by sectional conferences on the following subjects: land resources, mineral resources, water resources and power, industry and commerce, transportation, community and city, education and welfare, and Columbia Basin. The conference was under the general chairmanship of Marshall N. Dana, regional advisor of the PWA for Oregon, Washington, Idaho and Montana. About 400 representatives registered for the conference, and total attendance reached 1,600.

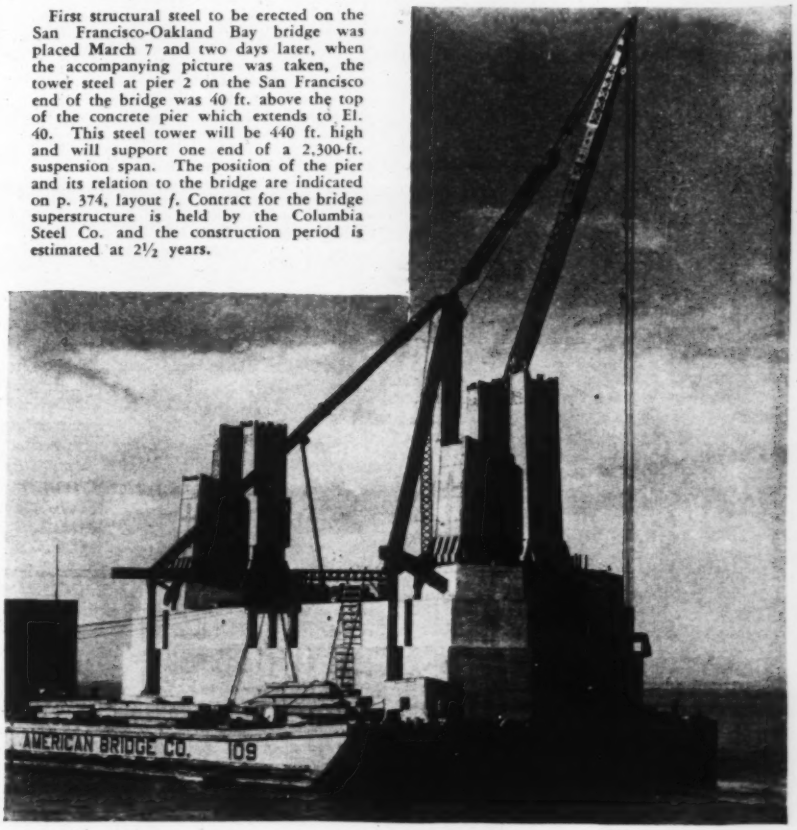
In opening the conference, Mr. Dana stated that the purpose was to knit together the official agencies and the citizens of the Northwest to make the most profitable use of public works projects authorized for this region, and to outline, subject to planning tests, a further program of public works of value to cities, states, drainage areas and the region as a whole.

Much interest centered around the economic use of Bonneville and Grand Coulee power in the section meetings on water resources and power and also in the section on industries and commerce. These gatherings were told by John P. Hogan, consulting engineer, New York, a member of the consulting board on the Bonneville Dam project, that stimulation of industrial development is the key to the sale of Bonneville power. Assuming that 2,800,000,000 kw.-hr. per year at Bonneville are reasonably firm and commercially salable, and assuming this power distributed among 800,000 people who could be economically reached, it would require consumption of 5,000 kw.-hr. per year per person. Even in New York state with Niagara Falls and a highly industrialized population, only 1,000 kw.-hr. per capita per annum are consumed in all industrial and commercial use.

In the consideration of industrial development, the power investment is only the beginning. For every dollar invested in power development, from $10 to $20 must be found to provide factories and equipment for its use, housing employes and new population, and other investments of a collateral nature. Assuming Bonneville power to cost fifty million, there must be found, largely from private investors, from a half billion to a billion dollars of this kind of investment money, and in addition, a large amount of public capital must be provided for municipal

STEEL ERECTION STARTS ON THE SAN FRANCISCO-OAKLAND BRIDGE

First structural steel to be erected on the San Francisco-Oakland Bay bridge was placed March 7 and two days later, when the accompanying picture was taken, the tower steel at pier 2 on the San Francisco end of the bridge was 40 ft. above the top of the concrete pier which extends to El. 40. This steel tower will be 440 ft. high and will support one end of a 2,300-ft. suspension span. The position of the pier and its relation to the bridge are indicated on p. 374, layout *f*. Contract for the bridge superstructure is held by the Columbia Steel Co. and the construction period is estimated at 2½ years.



utilities and facilities for the increased population. If this capital is to be attracted, the general scheme of industrial development must be wisely planned.

D. C. Henny, consulting engineer, Portland, another consultant on the Bonneville project and chairman of the state Bonneville Dam Commission, urged that the price of Bonneville power be set low enough so that other factors less favorable to industrial development in the region might be partly offset. He pointed out that while transportation, land, climate and living conditions in the neighborhood of the Bonneville site were generally favorable, its distance from world markets and the lack of raw materials in the immediate vicinity would operate to discourage investment of private capital and the development of industrial possibilities unless the price for power could be set at an extremely low figure. He urged that the government base its price for this power not solely on the cost of the project, allocating the major portion of this cost to power, but that it recognize the indirect benefits from a large industrial development, and set the price at a point low enough to offset some of the disadvantages in the competitive situation.

It was the recommendation of the conference, in essence, that the national program of advanced planning be carried out through state planning boards, which shall be responsible for planning state wide projects, other than Federal, and which shall stimulate, direct and aid other local planning boards. A program and policy for the Pacific Northwest Planning Conference was also adopted, namely, that the conference shall discuss and further the social and economic uses of public works and lands; shall develop general plans and policies for social, industrial and economic progress in the Northwest, and shall be a fact finding and fact coordinating body leaving recommendations for specific projects to the regularly constituted local state and regional planning boards.

PWA Outlines Expected Rate of 1934 Expenditures

Studies indicate that about $1,380,000,000 of the Public Works funds will find its way into citizens' pockets during 1934, according to reports released by Administrator Ickes. The peak of this expenditure would be about $164,000,000 in June. Statutory and executive allotments equalling about one-third of the entire PWA fund were not included in the compilation.

A steadily increasing volume of expenditures per month is indicated, according to the report, for the spring of 1934 with further acceleration in early summer. The peak month of June will be flanked on both sides by the two next best months for major expenditures. The flow of funds will decline through the fall to a minimum of less than $100,000,000 per month by the end of the year as weather conditions tend to slow down the construction industry.

About one-half billion dollars of the federal and non-federal allotments would remain to be expended in 1935, and about one hundred million would be left for 1936. The 1935-36 expenditures would be composed chiefly of large-scale projects which are neither feasible nor economical to complete in a shorter time.

John E. Armstrong, of C.P.R. Elected President of A.R.E.A.

At its annual meeting in Chicago, Ill., March 13 and 14, the American Railway Engineering Association elected president for the ensuing year, John E. Armstrong, assistant chief engineer, Canadian Pacific Railway. The meeting is reported on p. 386 of this issue.

Mr. Armstrong was born in Peoria, Ill., in 1886. He was graduated from Bradley

John E. Armstrong

Polytechnic Institute, Peoria, 1905, and from Cornell University, 1908. He entered railroad service in 1901 with the Toledo, Peoria and Western Railway and served in various capacities during his summer vacations until graduation. Between 1908 and 1912 he was an assistant in the engineering corps of the Pennsylvania Railroad. He became an assistant engineer with C.P.R. in 1912. In 1928 he was made assistant chief engineer.

He was elected director of the A.R.E.A. in 1927 and was first vice-president during the past year.

PWA Loan Authorizations Now Coming from Reserves

The loans authorized by the Public Works Administration after the $3,300,000,000 fund had been declared exhausted are backed by sufficient available money to cover these commitments, according to PWA officials. Such announcement answers the many questions raised by the granting of recent loans. The source of the funds lies in various reserves that had been set up; some of these are:

Administrative reserve	$25,000,000
General project reserve	35,000,000
Housing reserve	100,000,000
Railroad reserve	196,600,000

The last item, originally larger, has been reduced to the figure indicated. Of this total, earmarked for railroad loans to permit the purchase of rails and equipment, $152,932,000 is already under contract. All of this figure, except $5,000,000, will be spent this year, according to PWA information. Only a small amount of PWA funds has been released for reallotment by the rescinding of previous loan authorizations.

No commitments have been made against funds to be provided in the future. However, the allotments made for one year's work on large federal projects (such as All-American Canal, $6,000,000; Boulder Dam, $38,000,000, Grand Coulee $15,000,000, Casper-Alcova $12,000,000) anticipate that further funds will be appropriated or allocated at a later date to carry them to completion. It is estimated that such projects constitute a lien of approximately $200,000,000 on any new money made available for public works.

London To Replace Chelsea Bridge with Suspension Structure

Following the decision last fall of the London County Council to reconstruct the Chelsea bridge over the Thames at a cost of £480,000, engineering studies have been under way, and it has recently been announced that a suspension design has been agreed upon. The bridge will consist of a central span of 332 ft. and two side spans of 163 ft. each. There will be a 40 ft. roadway and two 12 ft. sidewalks. Plans were prepared by Rendel, Palmer & Tritton, consulting engineers, Westminster.

Code Compliance Required On All PWA Work

(Continued from p. 394)

between PWA and the American Federation of Labor.

Pertinent sections of the President's executive order read:

"1. (a) All invitations to bidders hereafter promulgated by or in behalf of any executive department or independent establishment or other agency or instrumentality of the United States, including Government-owned and Government-controlled corporations (all of the foregoing being hereinafter described as agencies of the United States), shall contain a provision to the effect that no bid will be considered unless it includes or is accompanied by a certificate duly executed by the bidder stating that the bidder is complying with and will continue to comply with each approved code of fair competition to which he is subject, and if engaged in any trade or industry for which there is no approved code of fair competition, then stating that as to such trade or industry he has become a party to and is complying with and will continue to comply with an agreement with the President under section 4 (a) of the National Industrial Recovery Act.

"(d) No agency of the United States and no Government contractor or supplier shall hereafter accept or purchase for the performance of any contract or purchase order or enter into any subcontracts for any articles, materials, or supplies, in whole or in part produced or furnished by any person who shall not have certified that he is complying with and will continue to comply with each code of fair competition which relates to such articles, materials, or supplies, or in case there is no approved code for the whole or any portion thereof, then, to that extent, with an agreement with the President as aforesaid.

"(e) The foregoing provisions of this order shall likewise apply to all contracts and purchase orders authorized by any State, municipal corporation, local subdivision, person, or corporation in connection with projects carried out or to be carried out, wholly or in part, with funds loaned or granted by any agency of the United States, and all contracts and agreements for the making of any such loan or grant shall contain a provision requiring the State, municipal corporation, local subdivision, person, or corporation receiving such loan or grant, to comply with the provisions of this order; provided that this paragraph shall not be construed as requiring the restriction of the use of materials to those produced within the United States nor to require price differentials in favor of such materials."

Section 2 of the order sets up a $500 penalty for falsely certifying as to compliance and provides for the handling of disputes.

Wisconsin Planning Board Includes Engineer Members

Personnel of the Wisconsin State Planning Board has been completed with several engineers in its makeup. The chairman is William E. O'Brien, State Highway Commissioner. Mr. W. Torkelson, state regional planning engineer; C. A. Halbert, state chief engineer; and Floyd Carlson, Kenosha, are on the commission. Jacob L. Crane, Jr., Chicago, is planning consultant to the commission.

Obituary

RICHARD P. MCNICHOLAS, 42, an assistant highway engineer in Maryland, died March 18 at a Baltimore hospital. He had been connected with highway work in Maryland for seven years.

JOHN S. LAMSON, for many years associated with the consulting firm of Fay, Spofford & Thorndike, Boston, Mass., died recently at his home in Arlington, Mass., after a brief illness.

JOHN F. AUGER, long associated with the building and construction industry at Utica, N. Y., age 64, died recently while spending the winter months at Tucson, Ariz.

ROBERT A. LONG, founder and chairman of the board of directors of the Long-Bell Lumber Co., died in Kansas City at the age of 83. Expanding from a small beginning in the lumber industry in the Southern States, Mr. Long extended the company's activities into major developments on the Coast, centered around the mills and activities at Longview, Wash.

FREDERICK EATON, age 79, first superintendent of the Los Angeles city water department, one of the first city engineers and at one time mayor of the city, died at his home March 9. Mr. Eaton was credited as the first person to take active steps toward development of a water supply for the city through utilization of the water-bearing lands in the Owens Valley and has often been referred to as the "father of the Los Angeles aqueduct." As chief engineer for the Los Angeles Railway he built the city's first electric lines.

WALTER D'ARCY RYAN, well known illuminating engineer for the General Electric Co., died at his home in Schenectady March 14. He was particularly well known for the advancing of the art of illumination in all its phases and the lighting effects at both the Panama-Pacific Exposition, San Francisco, 1915, and the Century of Progress at Chicago, 1933, were the results of his work.

WILLIAM HOWARD COURTENAY, for 54 years on the engineering staff of the Louisville & Nashville railway and chief engineer for 28 years prior to his retirement last fall on his 75th birthday, died recently at his home in Louisville. Graduating from Rensselaer Polytechnic Institute in 1879, he entered the service of the L. & N. and rose to the position of chief engineer. Following his retirement he served as consulting engineer.

W. H. WARDWELL, consulting engineer, Montreal, Canada, died in that city at the age of 60, March 14. Born in Buffalo, N. Y., Mr. Wardwell graduated from Cornell University and shortly after moved to Canada, working on the initial power development at Shawinigan Falls, Quebec. Moving to Montreal he spent the remainder of his life there in consulting practice, except for the war period when he served in the American army, rising to the rank of Major.

CONSTRUCTION STATISTICS OF THE WEEK

THIS WEEK'S contracts add up to the disappointing low for this year, $15,757,000. The drop is in both public and private and is due to the fact that few large contracts were awarded. The actual number of contracts is approximately the same as usual but the average size is lower. The average week to date for this year is $22,821,000, compared with an average of $16,858,000 per week for the corresponding period last year. This is an increase in dollar volume of approximately 36 per cent. Federal contracts are approximately the same as last week, $3,801,000 compared with the previous total of $3,720,000. State and municipal awards dropped to $13,512,000, 7.5 per cent below last week. Private awards were about half of last week's total.

Streets and roads awards increased about 24 per cent from the record low last week. This week's total of $5,562,000 is next to the lowest week this year in spite of this increase. Sewerage contracts dropped from $1,194,000 last week to $199,000 this week, industrial buildings at $1,500,000 held at approximately last week's total, commercial buildings dropped 80 per cent from last week, public buildings at $5,053,000 were only slightly below last week's total. Earthwork, irrigation and drainage awards at $1,153,000 were only slightly below last week.

The Woodrow Wilson High School awarded in District of Columbia at $1,043,000 heads the large awards this week. Highway lettings include $831,000 awarded by Missouri and $490,000 awarded by Indiana. The $615,000 dredging contract by U. S. Corps of Engineers in Michigan completes the large awards.

Municipal bond sales for construction purposes increased this week in number and dollar volume to more than double last week's total. Only one PWA allotment was announced, a grant to the state of Massachusetts of $450,000 for roads.

CONTRACTS
(Thousands of Dollars)

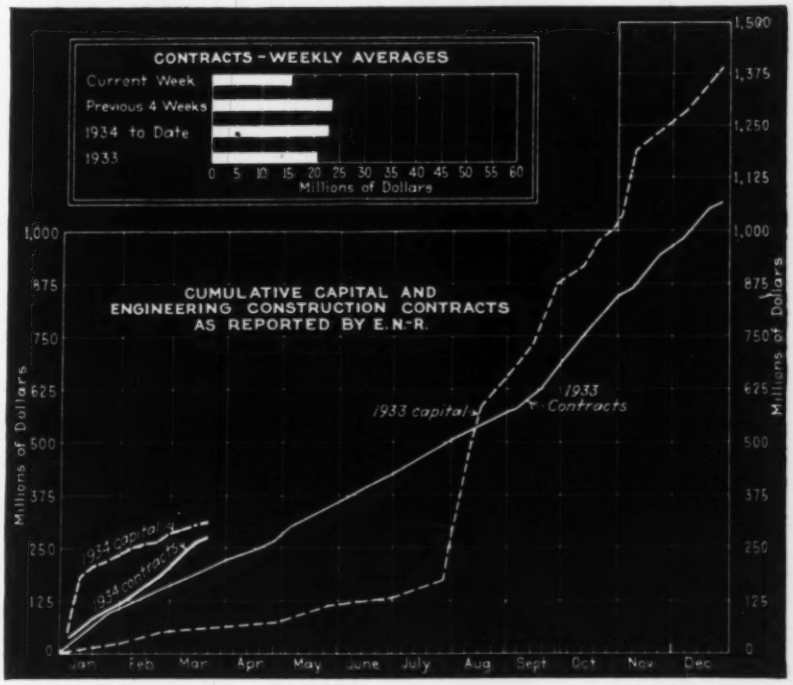
	Weekly Average Mar. 1933	Prev. 4 Weeks	Week Mar. 22 1934
Federal Government	$2,538	$4,078	$3,801
State and municipal	4,373	11,614	9,711
Total public	$6,912	$15,692	$13,512
Total private	4,675	7,978	2,245
Week's total	$11,587	$23,670	$15,757
Cumulative to date: 1933	$202,298	1934	$273,846

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1934	Week Mar. 22	Cumulative
State and municipal	$2,113	$52,407
PWA allotments, S&M	450	194,890
Corporate issues	70	10,595
PWA allotments, private	...	44,581
Total, Non-Federal	$2,563	$302,479
PWA allotments Federal Constr.	....	48,102
Total new capital	$2,563	$350,581
Cumulative to date: 1933	$68,000	1934 $302,479
Rescinded or reduced allotments (from 1933 PWA totals)		$43,323

INDEX NUMBER

E.N.-R.-Cost		E.N.-R.-Volume	
March, 1934	194.04	February, 1934	88
February, 1934	194.04	January, 1934	113
March, 1933	158.44	February, 1933	82
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		

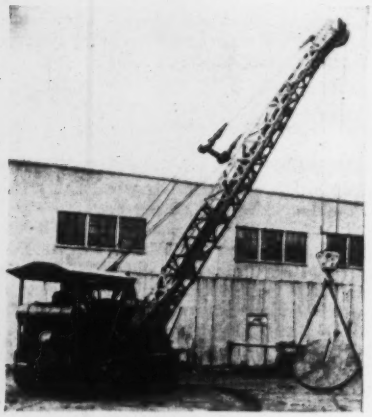


Construction Equipment and Materials

General Utility Crane Has Number of Uses

A new general utility crane has been introduced by the Harnischfeger Corp., Milwaukee, Wis. It has a wide range of uses, including the handling of material and industrial equipment and log and pipe handling. It is also convertible for clamshell crane, dragline scraper, pile driver or tractor service.

Designed primarily for faster handling of loads, the new crane is featured by a flexible drum arrangement. There are two side drums and a front drum, all of which rotate independently. Each drum has three forward speeds and one reverse speed. The live power-driven boom is quickly adjustable to any desired working angle and can also be readily removed. The machine has a high speed of 5.2 miles per hour and an intermediate speed of 2.6 miles per hour.



Harnischfeger general utility crane

The manufacturer states that in lifting tests with counterweight, the machine carried 12,000 lb. at a distance of 6 ft. from the edge of the traction. Without counterweight, it picked up 5,200 lb. at 4 ft. from the edge and traveled with it at 5.2 miles per hour. With detachable stiff-leg under the boom, the machine will lift 35,000 pounds.

Gasket-Type Coupling For Steel Pipe

A new gasket type of coupling for steel pipe has been announced by the Champion Machine & Forging Co., Cleveland, Ohio. According to the manufacturer this coupling makes possible the joining of straight plain-end pipes without grooving, threading, beveling or upsetting the ends. The couplings have been assembled on pipe and tested up to 4,000 lb. per sq.in.

The gasket is so designed as to provide a double seal, equally effective against either pressure or vacuum. Two special steel reinforcements, 180 deg. apart on the gasket, protect it from the pinching action of the two halves of the coupling when it is being asembled. The coupling consists of five distinct parts, two half coupling sections, one gasket and two bolts. Coupling sections are of drop-forged, special grade steel.

Champion "Positive Seal" pipe coupling

At the present time this coupling is made in sizes from 2 to 8 in. It can be used on wrought iron, steel, drawn or welded pipe.

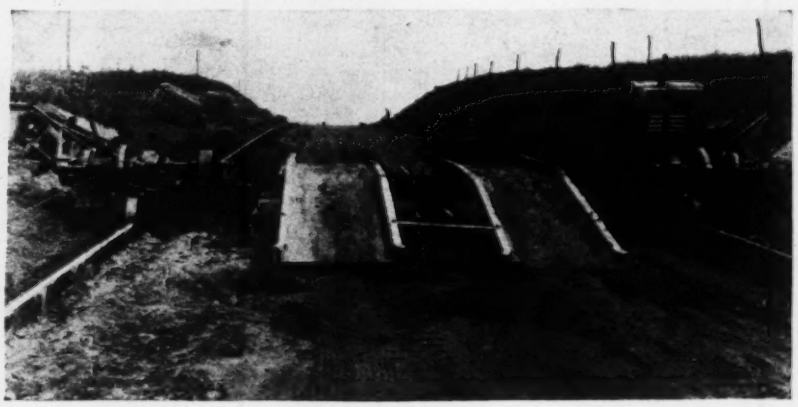
New Power Subgrader For Road Construction

A new power subgrader has been introduced by the R. B. Equipment Manufacturing Co., Royal Oak, Mich. The machine travels on the road forms and is moved ahead into the subgrade by two cables anchored about 200 ft. ahead.

Cutting knives work in a horizontal plane with a slight lateral motion, slightly below the line of the finished subgrade. They are built in 2-ft. segments and are synchronized so that only two are digging into the subgrade at any one time. The manufacturer states that because of this design feature a 25-hp. engine can be used and the subgrader kept sufficiently light in weight to avoid distorting the forms.

As the machine moves into the subgrade a flight conveyor picks up the excess dirt and places it on the shoulder. On the back of the subgrader is a strike-off which is set to the cross-section of the pavement subgrade, but from ¼ to ½ in. above it, to leave fine material for the roller.

R. B. power subgrader



The machine is provided with a bridge over which trucks can pass during operation. The weight of the bridge and the trucks is carried on separate wheels direct to the subgrade.

New Equipment in Brief

Scarifier. A powerful roller scarifier, hydraulically operated, is announced by the Hercules Co., Marion, Ohio. It is so designed that the scarifier teeth may be stopped at any desired point in the vertical movement of the tooth bar.

Demolition Tool. The Chicago Pneumatic Tool Co., New York, N. Y., has announced a new 75 lb. demolition tool which is particularly recommended for use in hard dense concrete or similar medium to extremely hard material. It is valve actuated and strikes a rapid, powerful blow. It has an overall length with retainer of 28 in. The new machine is designated as the CP-117 demolition tool.

Oil Tractor. Allis-Chalmers, Milwaukee, Wis., has announced the A-C oil tractor. The engine burns all fuels suitable for use in solid injection diesel engines of the type used in tractors and other automotive equipment. A diesel fuel pump is used to inject the cold charge into the cylinder. Ignition is electrical through the use of a magneto. The new tractor is built in two models, model "KO," developing 48 hp. and weighing about 11,200 lb., and model "LO," developing 76 hp. and weighing about 26,000 lb.

New Publications

WORTHINGTON POWER PUMPS. Worthington Pump & Machinery Corp., Harrison, N. J. 8x11. 4 pages. Specifications, capacities and sizes of vertical triplex single-acting power pumps.

CEDAR RAPIDS STRAIGHT LINE ALL-PURPOSE PLANT. Iowa Mfg. Co., Cedar Rapids, Iowa. 8 pages, 8½x11. Describes a new line of portable crushing, screening and loading plants.

GENERAL REFERENCE CATALOG, 1934. Austin-Western Road Machinery Co., Chicago, Ill. 24 pages, 8½x11. Illustrated catalog of road machinery.

CATERPILLAR DIESEL THIRTY-FIVE TRACTOR. Caterpillar Tractor Co., Peoria, Ill. 44 pages, 8½x11. Detailed description of this tractor and its diesel engine.

TYPE XVG GAS-ENGINE-DRIVEN COMPRESSORS. Ingersoll-Rand Co., Phillipsburg, N. J. 24 pages, 8½x11. Describes a new line of direct-connected gas engine driven compressors for air and gas service.

OVER THE ROUGH SPOTS. Stonhard Co., Philadelphia, Pa. 24 pages. Outlines treatment to preserve floors and methods of repairing and resurfacing.